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THE

ENGINEERING MAGAZINE

VOL. XVI. OCTOBER, 1898. No. 1.

A RATIONAL BASIS FOR ANGLO-AMERICAN CO-OPERATION.

By Sir Nathaniel Barnaby, K. C. B.

THE chairman of the senate committee on foreign relations, speaking recently at St. Paul, said: "It is manifest that the United States will be a great naval and military power, and certain exponents of European opinion, who until recently spoke with a condescending assumption of authority of intervening in the present contest, have abated the hauteur of their expressions." In the course of the same address he is reported to have referred to the relations between America and England in terms which have been received in England with great pleasure. "Unpleasant relations," he said, "have existed between the United States and England for years, due to the traditional aversion, aggravated by certain events in the civil war and by many minor irritating controversies, the worst feature of which is the fact that few of them have ever been settled. But through all this it has been felt by the people of both countries that a tie binds them together, however much they may irritate each other by straining it. It is very plain that a change of sentiment or expression, and of the general contour of the relations of the two nations, has taken place. The conviction, heretofore only imperfectly felt and only partially, infrequently, and fitfully acknowledged, is now clearly operative, and is openly and spontaneously expressed,—that one hundred and twenty-five millions of English-speaking people, who have established representative government and secured personal liberty in all parts of the world, whose civilisation is still progressive, who have taken no step backward in an expansion of influence and empire without comparison in history, are amicably approaching each other under the pressure of a great human evolution."

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The most obvious advantage of such an approach is the promise which it gives that misunderstandings which may arise in the future shall be amicably settled. The treaty of arbitration proposed by Lord Salisbury and not yet accepted by the United States was a possible way of taking advantage of the feeling expressed by Mr. Davis in the terms which have been quoted. The contracting bond was perhaps premature. Kindly feelings exist on both sides of the Atlantic, but they perhaps need strengthening before anything like a permanent treaty can be made. We may hope that the sentiment itself, without a bond, is strong enough to prevent diplomatists from blundering into conflict, and that war between the two countries is no longer possible under any fancied provocation. But it will be well to distrust diplomacy in the matter, and to trust rather to the methods by which two kindred souls approach and enter into life long alliance.

In such cases the best traditions of our race point first to the necessity for a conviction that there is a noble life-work in which the two may usefully and happily join. No less powerful conviction would have satisfied our Puritan ancestors when they made their domestic alliances. The fact that there is no such common life-work possible to the contracting parties explains the misery and emptiness of many of the marriages of to-day, and is of ill augury for some much-vaunted modern political alliances.

Mr. Davis refers to some of the ideals in which the English-speaking people are at one. In a striking letter to the London *Times* of July 29, Mr. Benjamin Kidd refers to another. The distinguished author of "Social Evolution," speaking of trade with the tropics (including in that term the belt of territory within the parallels of 30° north and south of the equator), says that the combined trade of the two leading sections of the English-speaking world with the tropics amounts to some forty-four per cent. of their total trade with the rest of the world.

In 1895 the trade of the United States with the tropics reached, in English currency, some 70,000,000 sterling, while that of the United Kingdom is estimated at 138,000,000 sterling. He goes on to say: "In the immense regions concerned there are embraced some of the richest territories on the earth's surface. But they are territories as yet, for the greater part practically undeveloped. Yet it must be remembered that it is in an interchange of commodities between these regions and those at present occupied by the European peoples that it is possible to have permanently operative, on the largest scale upon which it could be made operative in the world, the great natural principle underlying all trade—*i.e.*, that the interchange of products between peoples and regions possessing different natural capacities tends to be mutually advantageous. No serious attempt, at least no attempt of the kind which the importance of the subject appears to deserve, has so far been made to set forth the principles which should underlie our future relations with the tropical regions of the world. Over a considerable proportion of these regions at present we have existing a state either of anarchy or of primitive savagery, pure and simple, in which no attempt is made, or can be made, to develop the natural resources lying ready to hand. Over a portion of the remainder European powers hold control. In some of these cases this control is maintained on principles beyond the exercise of which the advanced peoples have certainly moved, and upon the practice of which no scheme of policy towards these regions could ever again be successfully submitted for public approval among ourselves. In England, at the present time, the feeling is probably instinctive that our relations with the tropics are likely to be extended rather than restricted in the near future. But, although we appear to be dimly conscious that we are living in a period of new and higher standards of national duty in such relations, although we even at times appear to catch sight of the high and important responsibility which the conscientious discharge of a national duty in these relations may involve in the period upon which we are entering, nowhere is there to be found any whole-hearted and consistent attempt either to justify the political relations which already exist, or to define the principles of any relations which ought to exist in the future."

Representative governments; personal liberty, civil and religious; the supremacy of constitutional and common law, and the subordination of all military tribunals thereto; the diminution of the area of national rivalries and the absolute exclusion of such rivalries from among the English-speaking people; the attempt to develop and promote the interchange of products between peoples and regions possessing different natural capacities,—in these things lie the worthy objects of our common life-work.

Nor is there anything in these ideals which can injure our neighbours. British diplomacy for the last fifty years, in relation to Russia, has been conducted in a spirit which would be speedily changed under the rule of such principles as have been set forth here. It would be seen that every new opening for the commerce of Russia will tend to bring her into line with us, and every ship which she builds will be an additional reason to her for keeping the peace with a more powerful maritime people. Even to-day it must be sorrowfully confessed that the British foreign office moves in the fetters of a bad past.

When the ideals of two parties are seen to be alike, and the opportunity for noble work in common is realised, another stage is entered on; the lover brings gifts. In this case neither party has any gift to offer of which the other stands in any need. The gifts can be only expressions of good will and confidence. It is the desire to point out how this may be done which must justify this article.

There is, first, the gift of joint nationalisation for the seamen, so that every enrolled seaman may, for the time being, claim the nationality of the flag under which he may be serving, whether it be the British Ensign or the Stars and Stripes.

According to the British foreign enlistment act of 1870, America is a foreign State; the act reads as follows:

> If any person, without the licence of Her Majesty, being a British subject, within or without Her Majesty's dominions, accepts, or agrees to accept, any commission or engagement in the military or naval service of any foreign State at war with any foreign State at peace with Her Majesty, and in this act referred to as a friendly State, or whether a British subject or not within Her Majesty's dominions, induces any other person to accept, or agree to accept, any commission or engagement in the military or naval service of any such foreign State as aforesaid, he shall be guilty of an offence against this act, and shall be punishable by fine and imprisonment, or either of such punishments, at the discretion of the court before which the offender is convicted.
>
> If any person, without the licence of Her Majesty, being a British subject, quits, or goes on board, any ship with a view of quitting Her Majesty's dominions, with intent to accept any commission or engagements in the military or naval service of any foreign State at war with a friendly State, or, whether a British subject or not, within Her Majesty's dominions, induces any other person to quit, or to go on board, any ship with a view of quitting Her Majesty's dominions with the like intent, he shall be guilty of an offence against this act, and shall be punishable by fine and imprisonment, or either of such punishments, at the discretion of the court before which the offender is convicted.
>
> If any person induces any other person to quit Her Majesty's dominions, or to embark on any ship within Her Majesty's dominions, under a misrepresentation or false representation of the service in which such person is to be engaged, with the intent, or in order, that such person may accept, or agree to accept, any commission or engagement in the military or naval service of any foreign State at war with a friendly State, he shall be guilty of an offence against this act, and shall be punishable by fine and imprisonment, or either of such punishments, at the discretion of the court before which the offender is convicted."

The gift offered to the United States should be the right to claim every British seaman or officer under her flag as an American citizen, made so by the flag during his period of service.

Next she should be invited to make an exchange of gifts. Citizens of the United States serving under the British flag should also be held to have changed their nationality during such period of service. Acts which would be treasonable if committed by British seamen under the British flag should be regarded as equally treasonable when committed by an American under that flag. The same rule should apply to Britishers serving under the Stars and Stripes.

The time would come when honours from the crown would be won by Americans serving under the British ensign. However high those honours might be, it is to be hoped they would be offered gladly and worn with pride.

America should be invited also to join Great Britain in establishing, on the coasts, State elementary nautical free schools for giving two years' training at the public expense to lads living in the neighbourhood of the schools and desiring such training, the lads to be perfectly free, during their training or after its completion, to engage in ships of any nationality, or otherwise to dispose of themselves. Their speech would naturally favour their entering under the American flag or our own, if they decided to follow the sea. If we thus gave each other our sons, we should, as Mr. Gladstone said, corroborate the bonds which unite us.

England moves with decision in the expenditure of money upon ships, but she is strangely unready to interfere with the rights of the ship-owners to engage foreign seamen to serve under her flag. They may engage men of another tongue and without nautical training.

She is now considering the possibility of enrolling colonial seamen in her naval reserve. The 75,000 men engaged in deep-sea and inland fishing in Canada, for example, have never been a recruiting material for the naval reserve. A clause has been added to the merchant shipping bill now under consideration, designed to induce ship-owners to enter apprentices, offering to them in return a reduction in the light dues paid by any ship which carries boy sailors between the ages of fifteen and nineteen, such boys being enrolled, and agreeing to serve, in the royal naval reserve.

It looks as if the ship-owners would decline to co-operate in such a scheme. But it is certain that they would gladly engage English-speaking lads who had had one or two years' training in boat work, in the use of fire-arms and of nautical instruments, and who came with certificates of character from Liverpool, from New York, or from a British colony.

What is to prevent the establishment of such relations between the United States and Great Britain? Some English people regard the Irish influence in America as being hopelessly hostile. Such a feeling may well exist where distrust of the Irish people at home has warped the judgment. The English Home Rule party is silent at present. It is idle, say its leaders, to attempt to place the question in the front again, until the Liberal party has become united on a common platform from which that plank shall for a time have been excluded. But justice to Ireland will be a war-cry yet in the United Liberal party, and the sympathy and co-operation of the United

States, on some such lines as have been indicated, would put new life into those who love the Irish people and who would bury all rancour and distrust between British and Irish. The English Home Rulers wish for no better fellow-citizens than the educated, disciplined Irishman. They point with pride to the Irish constabulary, recruited in the most troublesome districts of that country, and they set before their sons as the noblest type of man the Irishman John Nicholson, who, at the age of thirty-five, ended his noble life while wresting Delhi from the rebel Sepoys, and who will be known to all generations as the great captain and hero of that heroic time.

It is not easy for the American to fit his tongue to the glibness of speech of the modern Britisher, and his continued belief in the necessity for pronouncing certain letters soon betrays him when he attempts to do it. He is almost as easily detected in his speech as is our English-speaking German cousin. But, apart from peculiarities in accent, which are stubborn, every national distinction seems to vanish in the 'tween decks of a man-of-war, where British, Americans, and Germans meet as comrades or friends. The writer was once in the ward room of a large German ship of war, in which the officers of two ships were assembled. One of these ships had just been accidentally sunk by her consort, and both ships' companies were in one ship. In this assemblage of officers two things impressed him. One was how homely the ward room seemed to one familiar only with British surroundings and not speaking the language of his hosts. The other was that nowhere had he ever seen such an assembly of handsome, well-built men. Many years afterwards he met, in Washington, a large party of senior officers of the United States navy. These were men hardened by time and weather ; their youthful bloom was gone ; and they were just, man for man, the counterparts of flag officers familiar to him at home. He could have fancied himself at a naval club dinner in London celebrating some British naval victory. There is a nationality of the salt seas which makes its mark upon its children. No racial differences among the citizens of the United States would be likely to interfere in the good work of welding together the sons of these islands and the children of the western continent in the warships of the two kindred peoples.

And, when these bonds have been strengthened by the recognition of our common ideals and of the work which lies before us ; when mutual courtesies have brought us heart to heart, especially upon the seas,—what then? We may sketch our own pictures of the future. The lover of these beautiful islands—the jewels set on the breast of the old continent—sees in them the common ancestral home of the latest, and perhaps the final, Masters of the Sea.

THE INDUSTRIAL INTERESTS OF THE UNITED STATES IN THE FAR EAST.

By Wharton Barker.

THE extension of occidental influence and commerce through the orient is the most striking and significant feature of an era which is characterized, above all, by international industrial competition and the struggle for new fields for industrial expansion. The sudden, and even dramatic, advance of the United States to its appropriate place in this movement, makes it vitally important to comprehend the character of the undertaking and the factors and influences which are to be considered. In discussing the problems of the Far East, I shall confine myself, as far as possible, to China, because the Chinese must play the leading part in the coming drama, and because I have a knowledge of the purposes of some of the great men who must act for China, the men who know of the latent wealth of the country and appreciate what development on American and European lines means.

I was asked in 1887 by Chang Yen Hoon, then Chinese minister to the United States, now vice-president of the Tsungli Yamen (foreign office), to consider proposals to undertake large enterprises in China in coöperation with Chinese selected by the imperial Chinese government. Of course I gave proper consideration to the proposals. I sent my representatives to China in the summer of 1887, and opened important negotiations at Tientsin, which were carried to the second stage at Philadelphia in the autumn of that year by Ma Kiet Chang, the special envoy of the Viceroy Li Hung Chang, sent to America to confer with me,—negotiations that covered a period of three months. A comprehensive plan for the development of China was agreed upon, of course subject to the approval of the imperial government at Peking. I hoped, and almost believed, that the greatest industrial and commercial undertaking of modern times was about to be put in operation under my general direction. The knowledge of the scope of the undertaking soon reached both political and commercial leaders in London, probably through Sir Robert Hart, the inspector-general of customs at Peking. At once every kind of pressure, public and private, was brought at Peking by Great Britain to prevent the ratification of what were known as the American concessions; for it was well known that, if the great undertaking was carried out as planned, the Chinese in a few years would reach a development that would place them in an independent position, and make American influence paramount. Great Britain wanted neither.

The British opposition would not, in my judgment, have prevented the ratification of the concessions, but for the bad impression made upon Chinese statesmen by the passage of the Chinese exclusion act by congress in 1888, and the belief that America was not keeping faith with China. The plans then halted have never been abandoned. I have kept up a correspondence with leading men at Peking, Tientsin, and Shanghai, and, upon invitation of very high Chinese officials, I went to China in the autumn of 1895 and met Li Hung Chang, Chang Yen Hoon, Sheng Taotai, now director-general of railroads, and other able and very influential men. I found at Shanghai and Peking representatives of several American, British, French, Dutch, and German syndicates, hard at work endeavoring to get concessions that would, in my judgment, have been destructive to Chinese autonomy, but, of course, most advantageous to foreign interests. The Russians were at work through the imperial Russian government, and had the inside track. The influence of Great Britain at Peking, once very great, had been lost, because the British government supported Japan and opposed China in the war of 1894–1895. Reports are made from time to time that this and that syndicate has received a valuable concession, but so far only Russians have succeeded in getting any substantial footing in China. Great Britain and Russia are at swords' points over the Chinese question, and Germany and France are probably in accord with Russia. Americans want to take part in the expected development, but are as yet ignorant of China, of Chinese character, and of the only way in which large undertakings can be carried on successfully in that country. Some Americans think the way is open for great undertakings not only in China, but also in other countries of the Far East, through retention of the Philippines by the United States, and therefore urge the taking up of great political responsibilities, of burdens that cannot be measured now.

In my judgment the Chinese empire cannot be broken up at this time by European nations, because the four great powers—Great Britain, Russia, France, and Germany—will not be able to agree upon the share of each in the proposed dismemberment, and no one of them can gain a permanent foothold in China without the consent of the others, not even through a great and costly war. The government of China may pass from the present Manchu dynasty to a Chinese dynasty, the result of some uprising of the people, or one or another of the European powers may for a time hold China in some kind of vassalage, but the great Chinese people cannot be broken up, nor can their industrial power be limited or controlled, by any outside influence. When Americans are ready to be honest in their dealings in China; when they are ready to work in coöperation with Chinese; when they are ready to invest large sums of their own money in China in coöperation with and through Chinese,—they can do great things in that country, bring to China permanent benefit, work to their own credit, and at the same time earn very large profits. The time has come for Americans to begin work in China, but they must coöperate with Chinese, they must be fair to the Chinese, to ensure success. They can do nothing on the lines on which British, Russians, Germans, and French have operated. Force cannot fail to make the Chinese stubborn and suspicious, while proper proposals of association and coöperation will give them confidence, and make them more than willing to have American assistance in the development of their great country. No small plan of operations will work now in China. Fifty syndicates, with capital of $1,000,000 each, working on independent lines cannot succeed, but one properly-managed American Development Company (if I may call it so), with an actual capital of $20,000,000 or $25,000,000, can do at once a most profitable business, for Chinese patience and industry, supported by large capital and directed by those who understand what they undertake to do and who appreciate the capabilities of the Chinese, will overcome the opposition to change that now exists. I believe the time of the reactionaries has almost passed, and that an impulse has been given that, when China awakens, will develop the cotton, woolen, silk, and other textile industries, and start the mining of coal and all kinds of metals and the manufacture of iron and steel, on a great scale not now thought possible. The building of great systems of railroads and canals—more canals than railroads—will shortly be undertaken.

The Mandarins no doubt will be able, for years to come, to prevent foreigners from getting concessions for any of these works, so long as the concessions asked for carry profit only to the foreign capitalists and are sought only on a basis of unfair discrimination in favor of foreigners and against Chinese. But the Mandarins will be powerless against the kind of foreign coöperation I propose, for great men, such as Viceroy Chang Chi Tong and Weng Tung Ho (who has now almost unlimited power at Peking), will surely coöperate, men who have a great hold upon the masses of the people, and upon the rich and able merchant class, as well as upon the ruling dynasty, because of their real ability and an established reputation for probity that no enemy has been able to break down. These men and their associates are not in accord with Viceroy Li Hung Chang and his associates, but they must coöperate with him because of his preëminent ability and perception. None of these men should be judged by European or American standards; they are trammelled by their training and surroundings. There is scarcely a need that these men have not seen and planned to supply, nor an enterprise they would not support on the basis which I outline.

China, beyond a doubt, is a country of unsurpassed natural resources. It is also unquestioned that those resources remain undeveloped. There are anthracite coal fields more extensive and apparently richer than the anthracite fields of Pennsylvania; there are bituminous fields that can be paralleled, if at all, only by our own; there are rich iron deposits in close proximity to the coal such as promise the production of iron and steel, for China's development, at prices at which American and British and German iron-masters cannot hope to lay down iron and steel in China; there is in the immense Yang-Tse valley, a valley paralleled by the Mississippi but running in an opposite direction, between degrees of latitude rather than longitude, an area suited to cotton culture that rivals, if it does not surpass, our own; and withal a country teeming with a laborious population, a population as bidable as it is industrious, insuring a development that will be appalling to the rest of the world, the moment the path is paved for the entrance of Americans and Europeans to give direction. And the Americans and Europeans who thus expatriate themselves will doubtless have opportunities to amass great fortunes. They will do so, however, by developing, not trade with China, but within China.

China is a country of unsurpassed productive capacity, but not, at present, of great consumptive capacity. And that consumptive capacity cannot grow, until her productive capacity grows, save so far as Europeans and Americans, anticipating the future, may loan capital to China, giving steel rails and locomotives and machinery in return for bonds, or so far as Chinese with hoarded gold and silver, also anticipating the future, may part with such metal and spend it to bring productive capital from abroad. But such importation of material can continue only for a time, for China has within herself the means to develop herself,—all save that energy possessed of the western nations and needed to give direction to the immeasurable energies of her people. And that energy she must import. She will have occasion, in her development, to import but little more.

Of course, as the productive capacity of her people increases, so will their consumptive capacity. As her people produce more wealth, they will consume more wealth; but there is no reason to believe that they will buy more of foreign peoples. They will, indeed, consume more goods, but they will be in a position to fill their own wants. This consumptive capacity will increase only with their productive capacity, and there is every reason to believe that they can and will make everything they want and at less cost than that at which other peoples can make and deliver such goods to them. Consequently they will buy of themselves, and not for long, or to any very great extent, purchase of others.

So we need not look to China for a great market for our products. When the development of China comes, whether as an empire, or as a divided people under the tutelage of others, Chinamen will supply their own markets. Chinese rail mills will roll the rails for Chinese railroads, Chinese manufactories will make the cloth to clothe Chinese backs. In other words, China will be no more dependent than she is now. She will be self-sustaining, capable of making at low cost practically all that her people consume,—an agricultural and mining and manufacturing country, not an importing country. The prime question for the people of the rest of the world will not be whether they may manufacture to clothe the backs of the Chinese, but whether the awakened Chinese may not clothe the backs of others.

The transportation question for China would be met more by the development of the canals than by the building of railroads. This is because the water-ways, natural and artificial, are already very numerous, and can be utilized as in no other country by the substitution for man-power, now largely employed, of steam, electric, or compressed-air motors. Twelve thousand miles of water-ways are now open in the Yang-Tse-Kiang basin, and an additional mileage of ten thousand miles of canal can be opened at a cost small in comparison with that of building railroads. The problems for the engineer are not serious. I do not believe that any great trunk-line of railroad in the populous parts of China will be constructed by foreign syndicates, for the Chinese have been awakened, by the grants already made to the Russian government, to the dangers to China from foreign control of the public highways. Foreign engineers will be employed to build railroads and canals, and at the start foreign general managers and traffic agents will be placed in charge; but soon all will be replaced by Chinese. These lines of railroads and canals will, if necessary, be built with associated Chinese capital, or with money taken from imperial and provincial treasuries. There is plenty of hoarded money in China, which its owners will invest in railroads, canals, steamboats, steamships, factories, and mines, when satisfied that their investment will be safe from the attacks of the official class, safe from unfair taxation and from blackmail. These men will be only too glad to invest their capital along with that of foreigners who will be just to their Chinese partners. This is proven by the Chinese in the Malay Peninsula and in Java, where they are large and most willing sharers in railroad and other corporate undertakings.

As I have said, the mineral wealth of China is great. I have seen reports of competent foreign engineers in the employ of the Chinese that leave no doubt of this. Gold is found in many parts of the country, and a large gold-yield from China has been prevented only because gold-washing and gold-crushing for private account are forbidden. I brought home from the province of Shangtung a fair sample, taken from a vein from 2½ to 4 inches wide that yielded $226,165 per ton; I believe no other so valuable mine has been found. This sample was assayed in Philadelphia. A way must be found, and no doubt will soon be found, to remove the existing bar to gold mining.

Investment in production, for export, of Chinese silk, cotton, and woolen fabrics will be found profitable, so long as the difference of exchange that exists now continues,—a difference due to the divergence between silver and gold.

There is a great opportunity for Americans (greater at this time for Americans than for British, Russians, Germans, Belgians, or French) to do business in China, not by following the plans suggested by the many syndicates now trying to get "Chinese concessions," but by the plan of uniting Americans with Chinese upon a scale of operations that will enable them to take up great undertakings and carry them until it is demonstrated that, well managed, they will return fair profits year in and year out. I am confident that in due time the Chinese will buy these developed enterprises, and release the original capital for new ventures. The field is almost without limit, but it cannot be occupied by those who employ the old and oft rejected methods so well known to the Chinese,—the methods of the ordinary promoter who has made himself odious all over the world. There are very few men in America who have the knowledge of the conditions that exist in China, the requisite relations with Chinese, and the capital needed for the successful doing of the business. There must be found a way to unite these requisites—knowledge of China, confidence of the Chinese and capital—before successful business can be carried on in China by Americans. I suggest the establishment of an American joint-stock company for doing business of all kinds within the borders of China, with an actual paid-up capital of at least $20,000,000. At the head of this corporation must be placed an American who has the confidence of both Chinese officials and merchants, a man who understands oriental as well as European and American methods. Of course the chief office of this corporation must be at Shanghai or Peking, not in America. I do not believe that such an American corporation would meet the opposition of either British or Russians, and I am sure that no opposition of Germans, French, or Belgians could hinder it in its work. I do not now go into detail, but some time I may present to the American investing public a plan most advantageous to Americans and to Chinese.

THE LATEST IMPROVEMENTS IN THE FRENCH LIGHTHOUSE SYSTEM.

By Jacques Boyer.

OF late it has been said frequently that the history of medicine may be divided into two periods,—medicine before Pasteur, and medicine since Pasteur. The science of lighthouse-construction has experienced a like renewal. It was in its infancy before the time of Fresnel, while, since his memorable discovery of the echelon system of lenses, it has continually advanced towards perfection, or, rather, it has been reconstructed from the very foundations. It is not my intention to exhibit the successive developments which the subject has experienced since the time of its revival, as this would greatly exceed the present limits of space. I rather desire to acquaint the readers of THE ENGINEERING MAGAZINE with the existing state of lighthouse practice in France, and, above all, to bring into prominence the latest ideas in this branch of applied science. The subject is especially noteworthy in view of the completion of the lighthouse at Penmarch, where a dangerous point on the Breton coast is indicated by the most powerful light in the world.

Before entering upon details, a few words as to the purpose of this article.

In the first place, it is assumed that the reader knows something of the various characters given to lights in order that their identity may be recognized. I may remind him, however, that in France the coast lights are divided into five categories: fixed lights, lights of occultation (occulted lights), colored lights, flashing lights, and mixed lights resulting from various combinations of the preceding. This being understood, we are in a position to begin the study of the "lightning-flash" system—the perfection of which seems destined to mark an important advance in the evolution of the illumination of coasts—and its application to the various kinds of French lighthouses. We shall then conclude by describing the light-ships and luminous buoys, without forgetting to speak of the hyperradiant light of Cape d'Antifer.

The most important modern innovation is that of the so-called "lightning-flash" lights, which enable the maximum lighting efficiency to be realized. This consists in the reduction of the duration of the flashes to the exact time necessary to permit the integral perception of their luminous intensity. The optical system is composed of a small number of lenses, and their rotation is effected in five, ten, or twenty seconds. In this way the loss of light is reduced, and, in consequence, the power of the lighthouse is increased without any increase in cost. These lightning-flash lights are divided into two classes,—those with uniform flashes every five seconds, and those with grouped flashes, in which the groups succeed each other at intervals of ten, fifteen, or twenty seconds, according as there are two, three, or four flashes in each group. Fig. 1 represents in plan the distribution of the light in a lightning-flash system with regular flashes, and Fig. 2 a lightning-flash system with flashes grouped by twos.

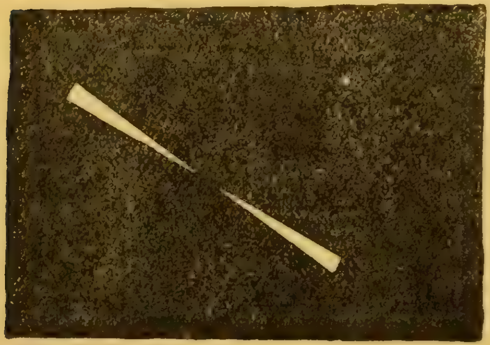

FIG. 1. LIGHTNING FLASH WITH REGULAR FLASHES EVERY FIVE SECONDS.

According to the investigations of Plateau, of Helmholtz, and, above all, of Charpentier, the time required for the integral perception is shorter as the luminous intensity of the source of light is stronger. It varies according to a law which has not yet been exactly determined, and concerning which further investigations are unnecessary, so far as lighthouses are concerned. The important practical point to be determined is *the duration of the integral perception of the light at its minimum perceptible intensity*, or, in other words, the time required for an observer to perceive, as a whole, the light of the lighthouse at the limit of its range. Now, according to the above law, this corresponds, at a maximum, to the duration of the flash, which, being sufficient at the limit of range, must, *a fortiori*, at less distances result in greater brilliancy. Hence the luminous range of a lightning-flash system is the same as that of a fixed light of equal intensity. Now we may discuss the relative determinations of the maximum duration of the flash.

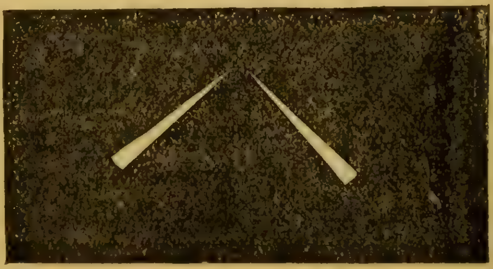

FIG. 2. LIGHTNING FLASH, FLASHES GROUPED BY TWOS.

The experiments of Charpentier upon the minimum period of perceptible intensity have shown that it is comprised beween $\frac{1}{8}$ and $\frac{1}{12}$ of a second for white light, and that it varies according to the surrounding light, and according to the constitution and adaptation of the eye. M.

Charles Henry, the director of the physiological laboratory at the Sorbonne, endeavored to avoid any external cause of error by determining this minimum, after having remained in darkness for five hours, and his results showed a notable difference from those obtained by the engineers of the central administration of lighthouses at Paris. While these latter have been evaluated to the hundred-millionth of a carcel-metre, — the minimum intensity, at which the light ceased to be perceptible,* has been found by M. Henry to be only one-third of this value.

In practice, however, many factors unite to render the minimum intensity much greater. The observer is inconvenienced by the movements of the ship, and the surrounding light is much stronger than that in a laboratory. It is therefore necessary to give to the flashes a shorter duration than that which the experiments of M. Charpentier seem to warrant. We may safely use a value of $\frac{1}{10}$ of a second. This is the duration which has been adopted for the electric lights of Creach (Ile d'Ouessant), Belle-Isle, and Barfleur. Experiments upon their visibility, made nightly from 1888 to 1892, failed to reveal any anomaly, and there has been no criticism on the part of the navigators. In fact, it has been shown that sailors are unable to detect any difference between electric flashes of $\frac{1}{10}$ of a second and those of three times that duration. This value, therefore, has stood the test of experience, and may be considered to have the sanction of usage.

On the other hand, since the luminous rays impress the navigator only for a very brief period, the eclipse, if there is but a single lens, must last almost through one revolution. This renders it necessary to give the apparatus a *very high rotative speed*, in order that the eclipse may be brief. We are limited to an average duration of five seconds. For a system with a single lens this would then be the time of a single revolution; for two lenses a revolution in ten seconds would suffice, or a revolution in twenty seconds for four lenses.

Let us now consider the case of a single-lens system, occupying in plan a half-circle, the other half being a reflector; and let us seek the conditions which must be fulfilled in order to obtain the maximum effect. If we suppose the entire horizon of 360° to be covered in five seconds, the angle included in one second will be 72°, and in one-tenth of a second the bundle of rays will extend over 7.2°. That is to say, with a single-lens apparatus, revolving once in five seconds, the eye of the observer will receive an impression during one-tenth of a second if the bundle of rays includes an angle of 7.2°.

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* That is to say, this intensity is equal to the light of one-one-hundreth part of a carcel burner seen at a distance of one kilometre through a perfectly transparent atmosphere. The carcel, or carcel burner, is about equal to ten English spermaceti candles.

By concentrating the entire amount of light into this reduced angle, the intensity of the illumination and, in consequence, *the range of the lighthouse,* will be augmented, the source of light remaining unchanged. Now, in order to produce a bundle of rays having this horizontal divergence of 7.2°, the lens system must have a focal distance which shall cause the extreme rays to subtend this angle. An elementary geometrical calculation shows that the horizontal divergence of points placed at a distance l from the focus for a flame of the diameter d, is given by the equation: $d = \frac{7.2^\circ}{360^\circ} \times 2\pi l = \frac{1}{8} l$, or $l = 8d$. When the apparatus has a two-lens system, since the velocity of revolution is one-half as great, the diameter of the flame is reduced one-half, and then $l = 16d$, while for an apparatus with a four-lens system $l = 32d$.

For lightning-flash lights to be used with mineral oil the most available combination is that of a single-lens system furnished with a spherical reflector of silvered glass. The lens utilizes one-half of the light emitted by the flame, and one-third of the balance is returned by the reflector. The hemispherical arrangement not only is the cheapest, but also possesses the advantage of permitting free access to the lamp by the keeper. The principal objection to it is that it requires a larger flame than the other forms. For this reason it is not used for lighthouses above the third order.* Under these conditions the power of a flash-light of this order is about double that of the old-style light of the first order formerly used on the coasts of France.

Flash-lights of the two-lens system, although utilizing only one-half the entire light for each flash, may be applied to lights of every order, even including the first, because they involve the use of the smaller flames only.

Early in 1892 there was erected on Point Senétose, in Corsica, a light of the fourth order, with a four-lens system, and in 1893 the old fixed light at Titan was replaced by a flash-light of the third order. Finally, in 1895, the light at Hourtin was installed. Its optical system (Fig. 4) is contained in a lantern 3.5 metres in diameter, placed upon a square tower (Fig. 4). It is supported by a cast-iron platform, which holds the vertical spindle upon which it rotates. The two reservoirs of oil from which the burner is fed are placed in the upper portion. A regulating device placed in the feeding tube maintains a constant level of oil at the burner, whatever the height may be

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* The French administration of lighthouses divides the lights into seven orders, according to the focal distance of their optical systems in millimetres. The arrangement is as follows: First order, 0m, 920 mm.; second order, 0m, 700 mm.; third order, 0m, 500 mm.; fourth order, 0m, 250 mm.; fifth order, 0m, 187 mm.; sixth order, 0m, 150 mm.; seventh order, 0m, 100 mm.

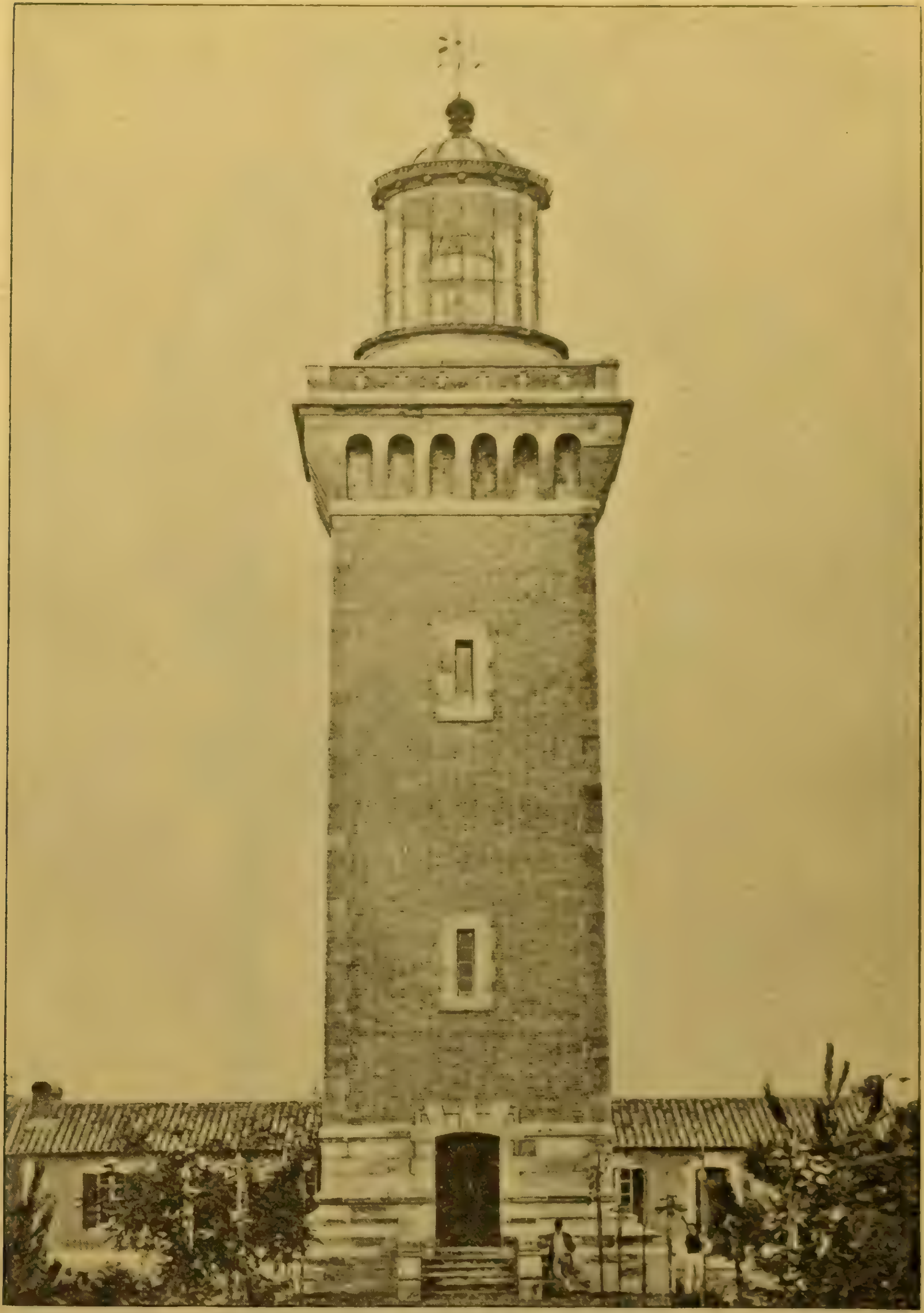

FIG. 3. LIGHTHOUSE OF HOURTIN, GIRONDE.

in the reservoir. A ladder fixed to the platform permits entrance through a trap to the lantern, so that the burner may readily be reached. The rotating mechanism consists of a clockwork movement, driven by a weight acting upon a shaft. This shaft is carried by two

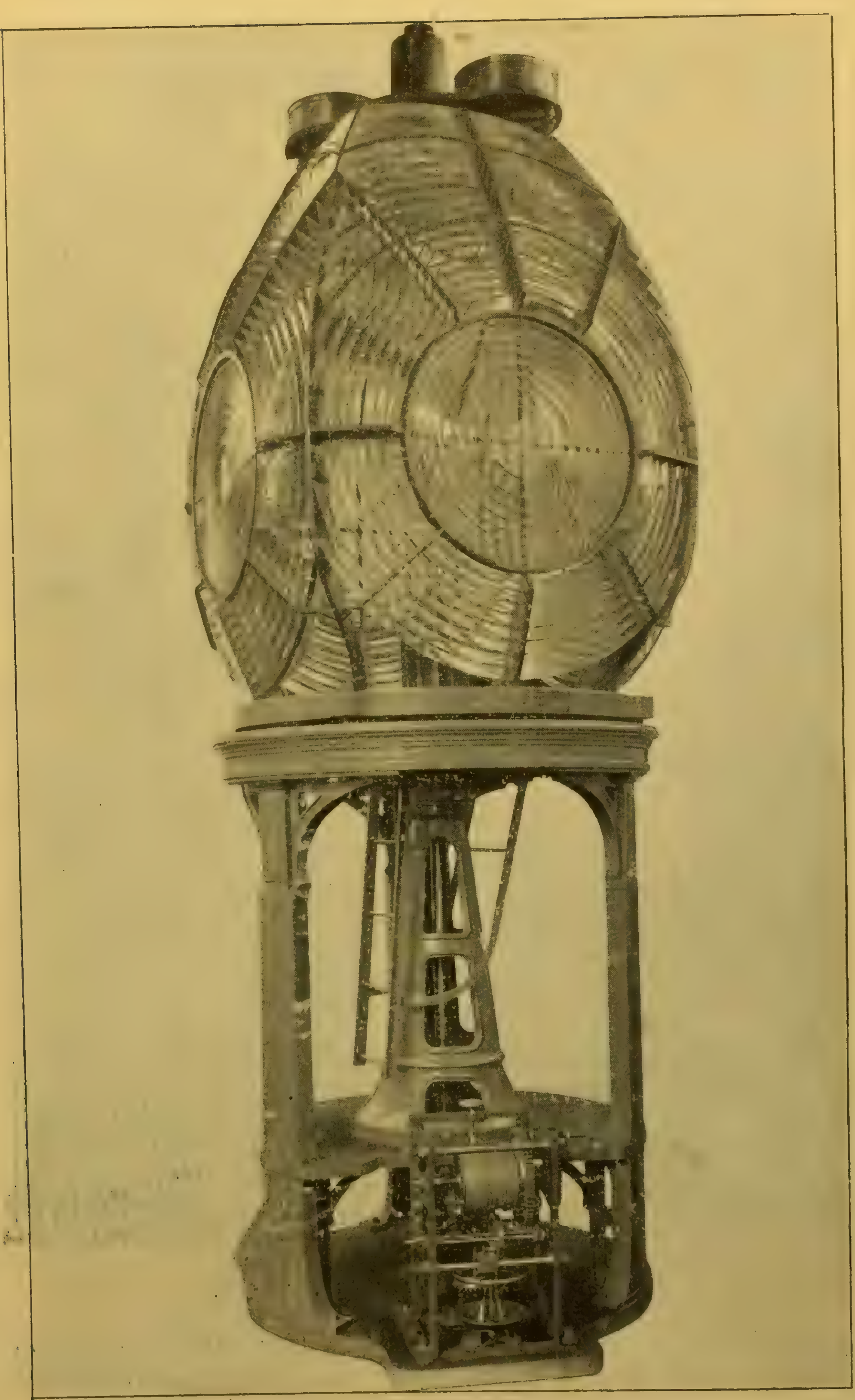

FIG. 4. OPTICAL APPARATUS OF THE LIGHTHOUSE OF HOURTIN.

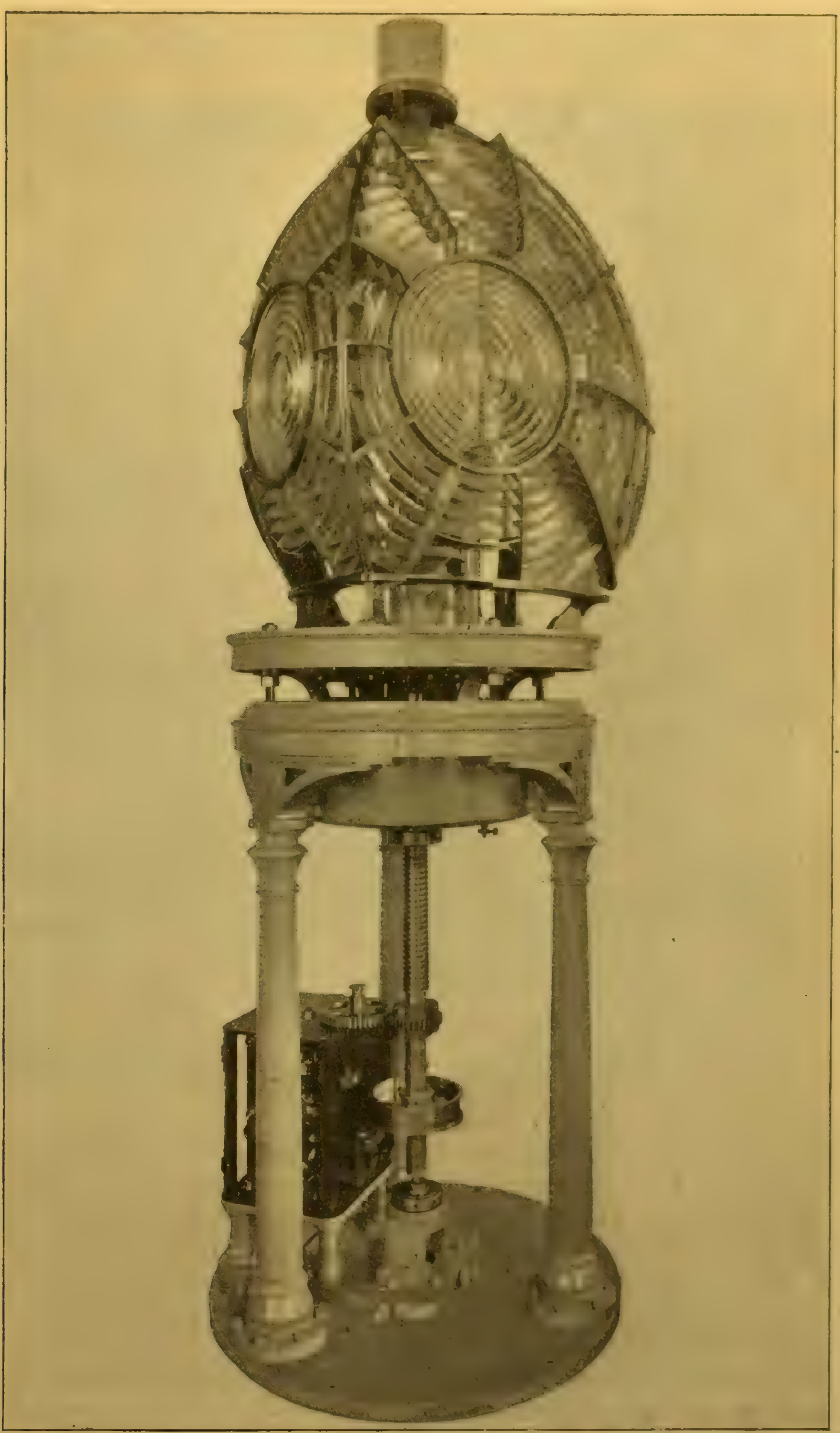

FIG. 5. APPARATUS FOR TWO-GROUP LIGHTNING FLASH, BUILT FOR THE PORQUEROLLES LIGHTHOUSE.

bearings that rest upon a pier on the floor, and is prolonged to the room below, where it rests in a socket. The arrangement is similar to that used in all lightning-flash systems. Attached rigidly to the shaft is an annular float, immersed in a vessel like it in form and containing mercury. The buoyant action of the liquid supports the weight of the apparatus, and greatly reduces the friction. In this way the resistance is much diminished, and a comparatively small driving weight is sufficient to move the clockwork by which the rotation is effected. With this mechanism it is possible to attain rotative speeds which were out of the question with the old form of revolving lantern carried upon balls or conical rollers.

The apparatus at the Hourtin lighthouse was constructed by MM. Barbier and Bénard, of Paris. The total cost, including the lens system, fittings, mercury, etc., was 57,360 francs. Its luminous power is 19,000 carcel-burners, and it emits regularly, every five seconds, flashes $\frac{1}{10}$ of a second in duration.

The lightning-flash system is also well adapted for use for groups of two, three, or four flashes. An example of this arrangement is found in an apparatus of the third order with two group flashes, recently erected at Porquerolles, one of the Hyères islands in the Mediterranean. The optical arrangement of this light is shown in Fig. 5. Assuming it to be divided by a vertical plane through the focus, each half is composed of two symmetrical and identical lens systems. A catoptric spherical reflector of silvered glass, together with the oil reservoir, occupies an angle of 90°, and returns to the lenses the light which it receives from the flame. This "dead" angle permits access to the interior, and simplifies the general arrangement. This apparatus, made by MM. Barbier and Bénard, cost 25,950 francs, and has a luminous power of 7,000 carcels.

The hyperradiant lighthouse of Cape d'Antifer, which formed a notable feature of the Paris Exposition of 1889, deserves especial mention. The lighthouse, which was inaugurated on July 15, 1894, contains a peculiar form of lantern, also constructed by MM. Barbier and Bénard. The optical system (Fig. 6), which is no less than 4 metres in height, is of 1.33 metres' focal length, and consists of six panels. Each lens system consists of twenty-six upper catadioptric elements, ten intermediate dioptric elements, and twelve lower catadioptric elements. The luminous power is equal to 22,000 carcels. The light appears in flashes one second in duration, followed by eclipses of about nineteen seconds. It is hardly worth while to go into further details of this light, for, although the first of its kind in France, it will also be the last. Its cost was very great (49,000 francs), and the lightning flash system offers a great superiority with a much

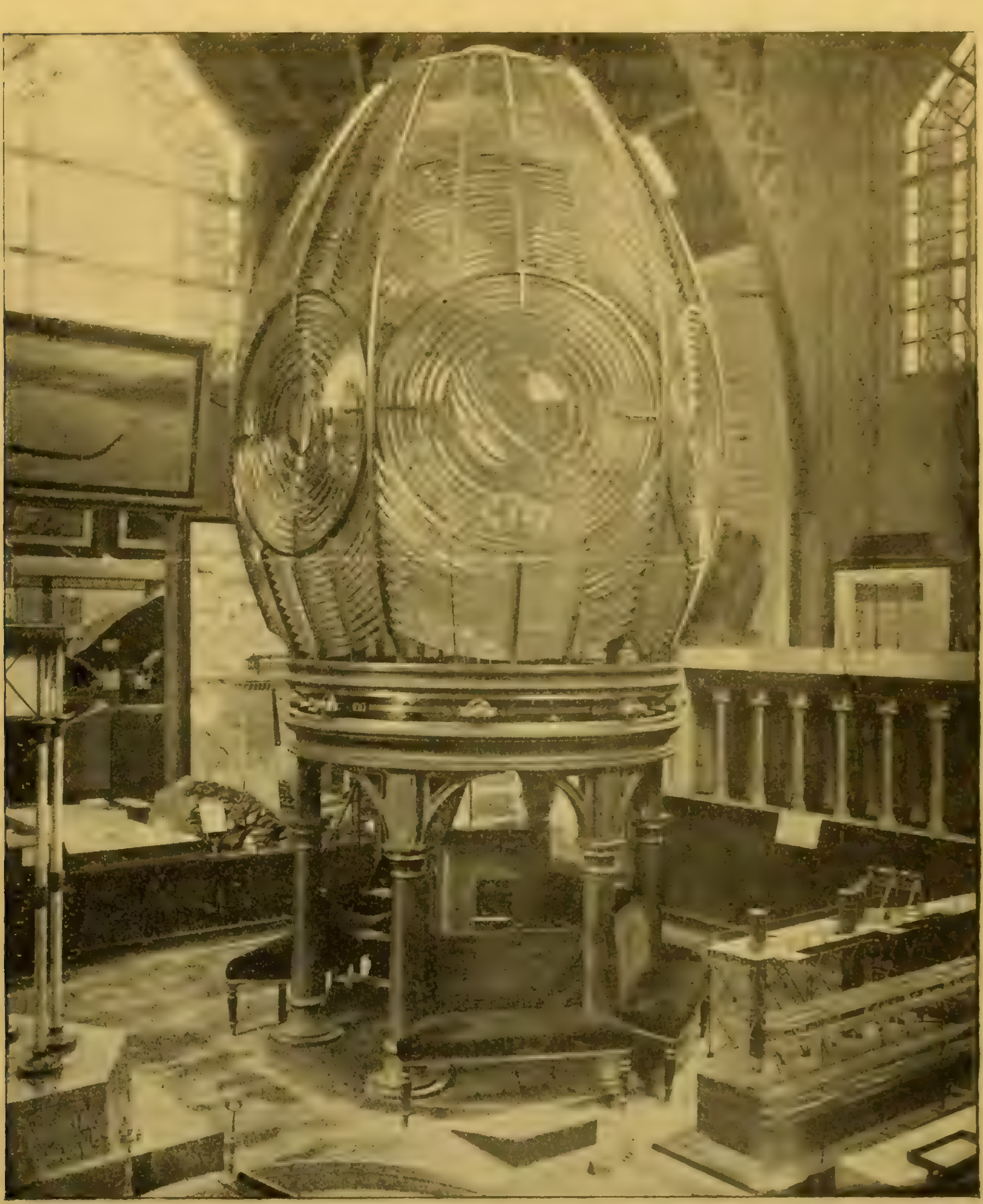

FIG. 6. HYPERRADIANT LIGHTING APPARATUS FOR THE LIGHTHOUSE OF CAPE D'ANTIFER.

smaller apparatus and less cost. Nevertheless this unique specimen is worthy of notice.

We now come to the consideration of electric lightning-flash lights.

A law, dated April 3, 1882, had sanctioned a programme offered by M. Allard, chief engineer of the French lighthouse department, which provided for the construction of forty-six electric lighthouses, to be distributed along the coast in such a manner as to form an uninterrupted belt of lights, under the ordinary conditions of atmospheric transparency. The work was begun by the construction of the light at Baleines (Fig. 7), at the Isle de Ré, and that at Calais (1883), and was continued by the construction of those at La Cauche (1884) and Dunkerque (1885). In 1886 an examination was made into the actual needs of navigation, whereby it was found that the principal object of lighting was rather to facilitate landings at certain predetermined ports than to aid in coasting from cape to cape, along

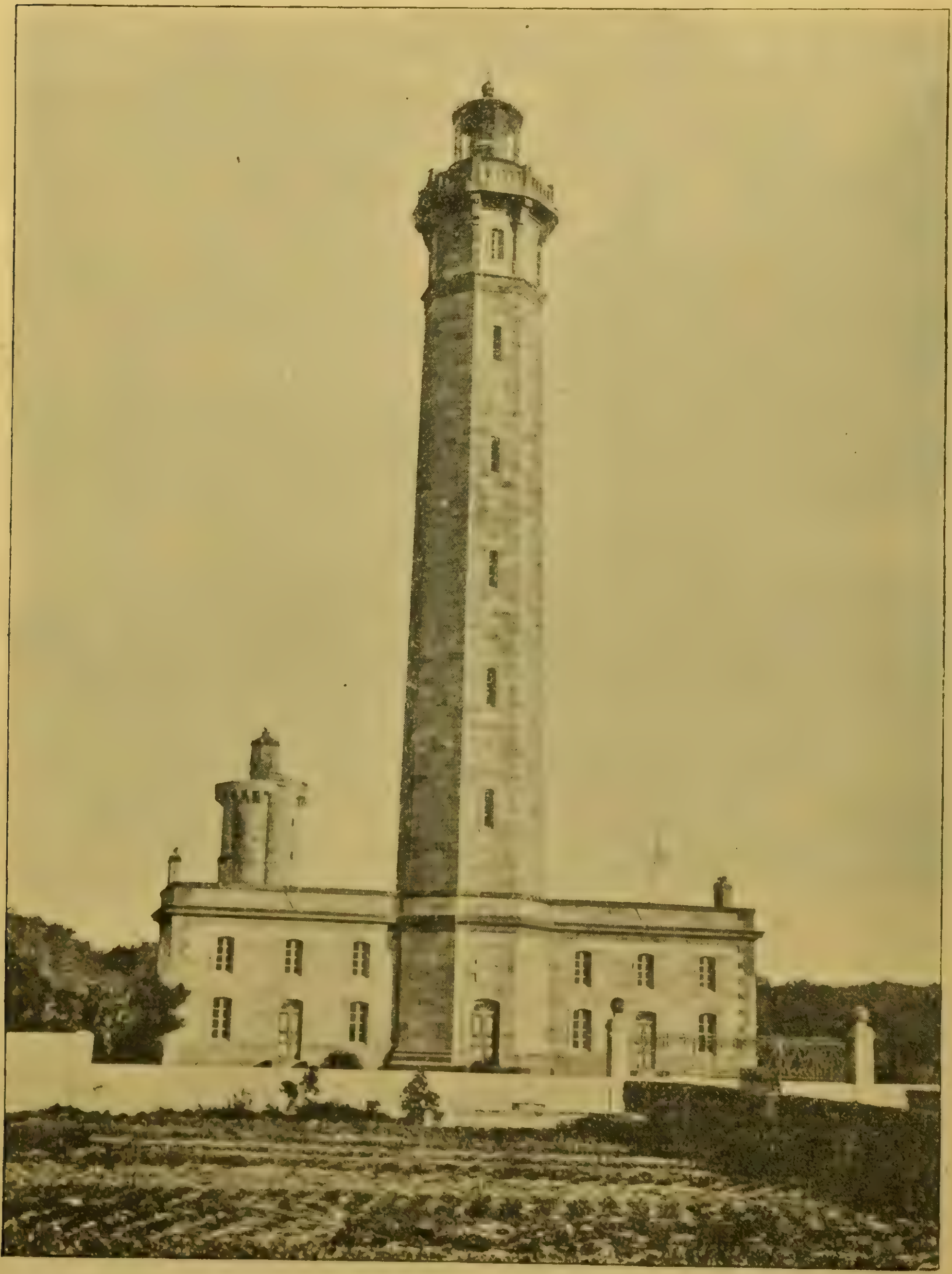

FIG. 7. LIGHTHOUSE OF BALEINES, ILE DE RÉ.

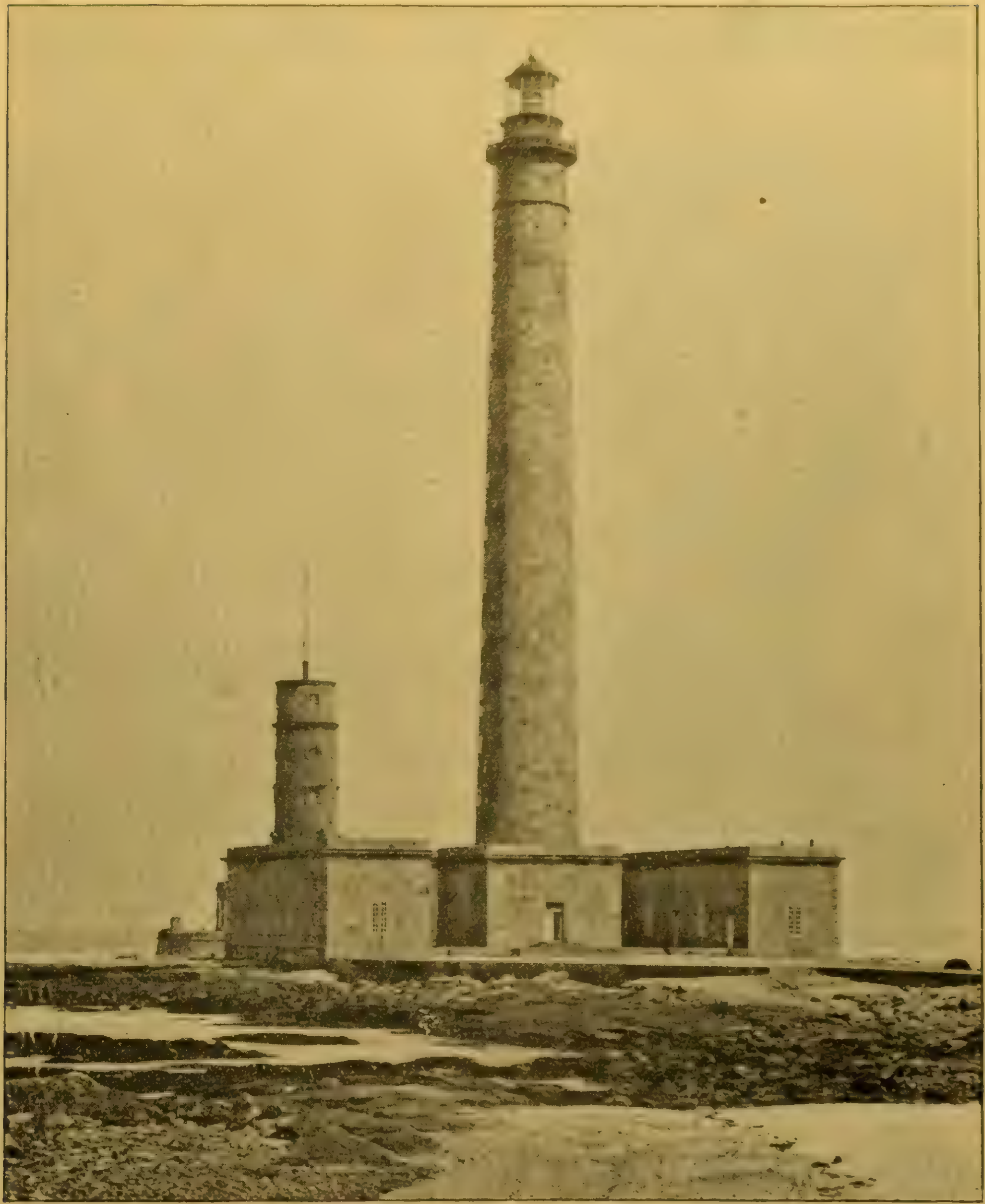

FIG. 8. LIGHTHOUSE ON THE POINT OF BARFLEUR, MANCHE.

the shore. It was then seen that the powerful electric lights should preferably be reserved for the lighthouses at the great ports, and that oil-lamps furnished indications sufficiently distinct for the other points. These considerations led to the decision to construct a smaller number of electric lighthouses, thirteen at most, and to proceed successively with those at Creach, on the island of Ouessant (1888), at Belle-Isle (1890), and at Barfleur (1892),—Fig. 8. These lights emit flashes of but a single color and very rapidly; for red and white lights are absorbed by the atmosphere in unequal

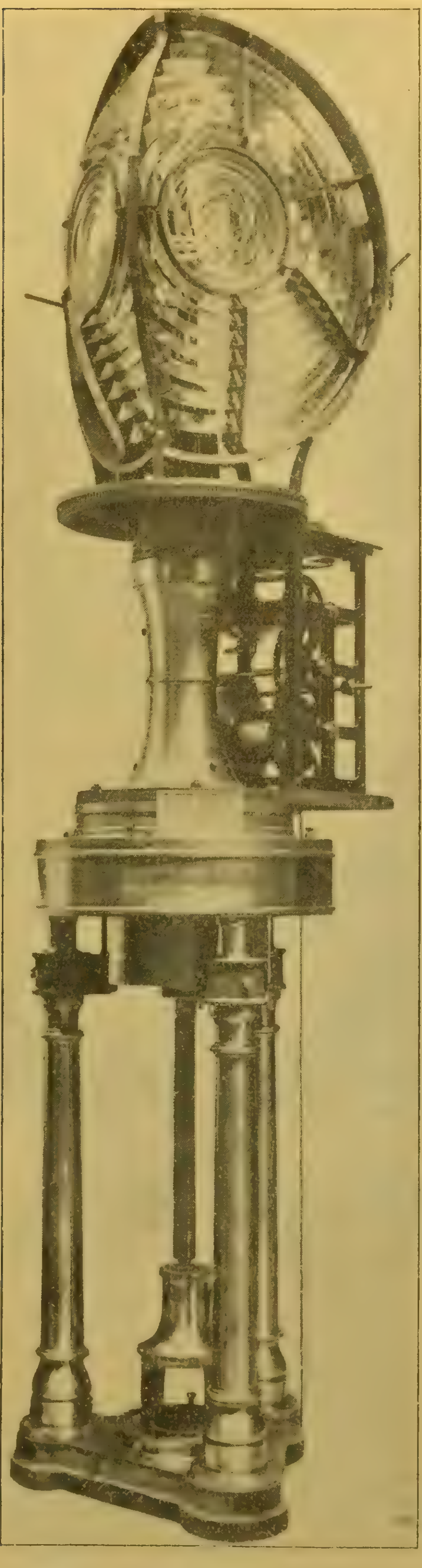

FIG. 9. OPTICAL APPARATUS, LA COUBRE.

proportions, and that it is impossible to insure an equal range for white and colored flashes,—a fact which renders any flash system involving a combination of colors especially unfit for harbor lighting and liable to result in serious consequences.

We will now proceed to the details of the system of illumination used in these three lighthouses, as well as in the electric lighthouses erected at la Hève in 1893, and at la Coubre and the island of Yeu in 1895. Fig. 9 represents the optical apparatus of the lighthouse at the Point de la Coubre, at the mouth of the Gironde. Both arrangements consist of a double system of lenses, giving groups of two flashes every ten seconds. Their luminous intensity varies from 2,250,000 carcels to 1,900,000, or 1,100,000, according to the state of the atmosphere. Without going into the details of the successive improvements which have been introduced, it suffices to state that, by suppressing the useless rays, reducing the number of lenses, and substituting bi-focal lenses for lenses of single focus, the apparatus has been rendered six times more powerful than before, the motive power and expense of operation remaining unchanged.

The complete description of the new and splendid Eckmühl lighthouse, which typifies all that is best and newest in work of this character, is reserved for the second and concluding portion of this paper.

LEGAL ASPECTS OF ELECTRIC STREET TRACTION IN ENGLAND.

By E. F. Vesey Knox.

THE people of England have cheap food, due, firstly, to free trade, and, secondly, to the enormous improvements in marine transportation introduced within the last twenty years. The consequent increase in commerce and manufacture has, within a brief period, more than doubled the English urban population. But the very increase of population has brought with it an increase in the burden of house-rent which threatens to neutralise the advantage that cheap food has given to England in the industrial competition of the world. A workman in the eighteenth century worked in his own workshop or his own house. Very often, as in the case of the hand-loom weavers in the north of Ireland, his house was in the country, and he brought his products to market in much the same way as the small farmer did. When the factory system was introduced, it became necessary for him to live near the factory. At first this presented little difficulty. But the development of industrial organization has required the concentration of factories where special facilities for transport are available. If the workman to-day wishes to live near his work, he has to pay dearly for the advantage of easy access. He has to compete for his few square yards of ground with tens of thousands of other workmen, with manufacturers, who covet the ground for factories and warehouses, and with shopkeepers, whose trade tends to become centralized in the same way as that of the manufacturer. Under these circumstances the workman has to pay a heavy price for his little home, and no form of legislation about ground rent can permanently reduce the price. The legislature may so tax ground rents as to divert the "unearned increment" into other pockets, or the municipality may use the money or the credit of the ratepayers to provide artisans' dwellings in central places at less than cost; but in some form the price must be paid, and, in the ultimate result, the increased cost of housing the workingmen means an increase in the cost of production. The London labourer receives more money than the labourer in the country, but he is no richer; the greater wage is expended in paying the higher rent. The wage cannot be reduced, any more than the rent can be reduced, by the wisdom of parliament. And thus it is that the concentration of industry which sixty years of cheap food have brought about in the little island of Great Britain threatens to become a disadvantage.

Various modes of mitigating this evil have been attempted. The first and most simple is to move the factory to a suburb or a country place. Where the industry is entirely self-supporting, this may be practicable and profitable. Industrial changes are practicable only when profitable. But this is very seldom the case. The only industries in which there has been any marked tendency to move outwards are those in which the cost of labour bears an unusually large proportion to the cost of the finished product,—such as printing,—and the progress of invention makes the number of such industries steadily decline. Every improvement in labour-saving machinery diminishes the proportion which the labour-bill bears to the cost of the product. Some people think that the distribution of electrical power on a large scale will enable industries to be carried on to advantage in smaller places within the radius of supply, but it seems at least as likely that the application of electrical power to manufactures will rather tend to concentrate factories by diminishing the dirt and noise which such a concentration involves where each factory has its own steam-equipment. Thus not much is to be hoped for from the distribution of factories; the tendency of the age is in the opposite direction.

The second expedient has been the erection of "model dwellings," by which a larger population is enabled to be housed on a small bit of land in the centre of the city. The extra cost of the land is thus divided among a larger number. But the old law of diminishing returns, which the Ricardian economists invented to express the fact that land cannot be made to yield an indefinite increase of crops, is equally true when applied to land as a place of human habitation. No amount of skill in the sanitary arts can make it possible to profitably and healthily house more than a certain number of human beings on an acre of land. Model dwellings have not done more than mitigate the appallingly large death-rate in central London, where it is sometimes five times as heavy as in the healthier, because less concentrated, suburbs.

Besides the greater cost of labour, and consequently of production, the concentration of urban population has many evil effects. There is the stunting of physical and mental growth in the children, rendering the labourers of the future less efficient. There is a vast amount of personal discomfort for the men and women, driving some of them to the public house and others into a condition of discontent which makes them less efficient labourers as well as dangerous members of the body politic. In the building trades (which in London are the largest single group of trades) labourers try to follow their work from one district to another. What a pity it is, from every point of view, that they cannot follow their work without changing their place of abode!

The middle and upper classes in the towns have long ceased to try to live near their work. They start work later in the day, after their breakfast, and find the journey to and fro less inconvenient than workingmen do. Some of them can afford to drive; others are season-ticket holders on the railways. Above all, they follow one route year after year, and have not to change their route with the changes in the place of work. But even they, especially in London, lose much of their efficiency as brain-workers from the inconvenience of access, or else pay immense sums as rent in the more accessible districts.

Obviously, then, the key to the problem of healthy living for all classes must be found in better means of moving to and fro within our cities, so that workers may obtain access to their work, though living at a distance from it. Better urban transit is the greatest of social needs. Necessity is the mother of invention, and invention has been busier in improving the means of urban transit during the past ten years than it ever was before. But the stupidity of parliament and county councils has prevented England, where the need was greatest, from sharing in the advantages which science placed within reach of our people. The railways cannot do more than part of the work. Some of them, especially the Great Eastern, have made great efforts, at enormous cost, to help in spreading population. But in many directions land is so expensive that further suburban lines are almost impossible, while the difficulty of providing sufficient station-accommodation in the centre is also increasing. The statistical officer of the London county council, with every temptation to make out a case against the companies, admits that, if every company gave up all the early morning hours to a five-minute service of workmen's trains, only a very small proportion of the London workmen would be taken to their place of work, while he does not attempt to tackle the much more difficult problem of how to get them home again in the afternoon. Underground electric railways may help towards the solution of the problem, but their construction is so expensive that they can never afford to give what, in the case of electric street transit, would be considered cheap fares; hence they must be put down as conveniences mainly for the middle class.

Furthermore, no sort of railway with big trains, stopping only at stations, can give the constant service which electric tramways can, not merely on main lines, but on cross routes, taking one from door to door. I am dealing with the social side of electric traction. From that point of view I venture to contend that the best system of transit is that which will take the humblest citizen from his own street-corner to his work, with dry feet, in good air, and at a cheap rate. The Londoner may very probably object that this is just what tramways do not do; they run only on main thoroughfares, and are really less useful to the dwellers in by-streets than the omnibus. But this is because tramways in London have never had a fair chance. The difficulty of promoting them, the insecurity of tenure, the municipal jealousy of private enterprise, and the unwillingness of the municipality itself to undertake new enterprises, have combined to keep London behind all the other cities of the world. The following is a list of the existing tramways within the metropolitan police district, with its six millions of people, giving in each case the length of single and double line.

Names of tramway and gauge.	Double line.	Single line.	Total length.
	m. ch.	m. ch.	m. ch.
Croydon	1.30	5.33	6.63
Croydon Corporation	5	9	14
Gravesend, Rosherville & Northfleet.	17	2. 3	2.20
Harrow Road and Paddington	1.57	1.10	2.67
Highgate hill	48	9	57
London	22.54	1.27	24. 1
London, Camberwell Dulwich	24	2.47	2.71
London County Council	4.18	10	4.28
London, Deptford and Greenwich	1. 9	3.63	4.72
London Southern	1.73	3.67	5.60
London Street	7.77	1.12	9. 9
London United	5.68	3.15	9. 3
North Metropolitan	38.78	12.57	51.55
South Eastern Metropolitan	61	1.64	2.45
South London	8.44	4.26	12.70
Total	96.21	43.52	139.73

There have been slight changes in ownership since the date of the parliamentary return from which these figures are taken, but the lengths are correct. What do these figures prove?

1. That the total length of tramway is only about one mile for every 43,000 people, as against one mile for every 10,000, which may be roughly taken as the average of progressive European cities, and one mile for every 3,000 which is rather a low average for America. London, according to the American standard, should have at least 1,500 miles of trolley line.

2. That nearly one-third of the total length of line is single line, thus creating the maximum of obstruction to other traffic and giving the minimum of public service.

3. That about half the total length of line is split up into thirteen separate undertakings, with an average length of about five miles each, thus minimizing the possibilities of through service by cross-

routes. Furthermore, with the exception of two short bits of cable, London trams are all drawn by horses.

To sum up the situation, London has a greater social need for good street transit than any other city. London presents the greatest field in the world for the profitable investment of money, whether private or municipal, in street-transit facilities. London is the richest city in the world, and its municipality can borrow at the lowest rate. Yet London has the most meagre system of street transit in the world, and this system is operated by the most antiquated method.

To explain this extraordinary state of things it is necessary to give a short statement of the English law concerning tramway undertakings, which is perhaps the most striking example in recent history of the power of a legislature to retard human progress.

Under the common law of England the highway dedicated to the use of the inhabitants at large cannot be broken up for any purpose without parliamentary authority. It is the king's highway, and to break it up is an offence against the king, punishable on indictment. In early times the king, of his prerogative, used to issue letters patent for the diversion, or widening, or closing, of highways, and in most European countries tramway concessions are granted by the executive. But in modern times the executive in England has no such power. In most American States the authority to break up the streets can be given by the municipality, and no legislation is required. In England, though the street is "vested" by law in the municipality, the municipality is rather a caretaker than an owner, and the permission of both executive and municipality is of no avail without the sanction of the legislature. George Francis Train got the consent of the municipality, and laid down a tramway, but he was indicted and convicted, like any pickpocket. With all the extensions of municipal authority within the present century, parliament has never yet given a municipality power to authorize, at its discretion, the breaking-up of the public streets. It will authorize private undertakers to break them up, or will authorize the municipality as undertakers to break them up, but it has never allowed a municipality to authorize others to break them up. In fact, parliament will not trust the municipalities, or even the county councils, to make their own bargains with those who desire to supply gas, or water, or electricity, or traction facilities, within the muncipal boundary. In most cases, on the other hand, parliament requires both the municipality and the executive to be satisfied in the first instance before granting traction facilities. Thus on the continent the promoter has to satisfy the executive only or the executive and the municipality; in America he has usually to satisfy the municipality only; in England he must run the gauntlet of all three.

There are several formal modes of proceeding by which a tramway may be authorized:

I. In Ireland, under an act passed in 1860, the privy council, to whom the authority of parliament has for this purpose been delegated, has power to authorize either urban tramways or rural light railways, and no purchase clause need be inserted. It must be largely due to this exceptional procedure that Ireland is so much beyond England in tramway facilities, in spite of the greater financial difficulties encountered there. Not merely has the act been useful in its direct effect, but it has been useful indirectly by accustoming municipalities to the beneficial results of security of tenure in encouraging enterprise. Thus it comes that even the tramways authorized by act of parliament have not been so strictly tied down in Ireland as in England. In Dublin and its suburbs, with a population little more than one-twentieth that of London and its suburbs, there are already in operation seventy miles of tramway. Much of this is already equipped for electrical or steam traction, and in the course of this year there will be no horse-trams left in Dublin, while extensions which are projected will bring the total tramway mileage to about one hundred miles. The corporation of the city of Dublin have extended the purchase term for forty-two years, at a rent, or way leave, of £10,000 a year, while some of the suburban lines are held in perpetuity.

II. In Great Britain the principal method of proceeding has been under the tramways act of 1870, which happily does not extend to Ireland. Mr. Shaw Lefevre told me the other day that he was proud of having carried that act through the House of Commons, but I venture to contend that no other act was ever passed which has done so much harm to the true interests of the people. It professed to be an act to facilitate the construction of tramways, and I believe this to have been its real intention. It allowed tramways to be constructed under provisional order of the board of trade confirmed by act of parliament, and, in cases where there was no opposition, it undoubtedly diminished promotion expenses. Where there is opposition, there is really no saving, for the opponents can fight the bill to confirm the provisional order before committee in both houses of parliament. Furthermore, the procedure is hampered by a number of limitations. It provides, in the first place, that for at least two-thirds the length of the tramway both the local and road authority must consent. In London the local authority is the county council, while the road authority is the vestry, or district board of works. The county council has persistently refused, without regard to the circumstances of the locality, to consent to any order for the construction of new tramways, or the electrical equipment of existing tramways, on the doctrinaire ground that such undertakings should never be allowed under private management, while they have not themselves constructed a single mile of line, and are at this moment discussing whether the time is ripe to equip for electrical working the lines which they are buying from the companies.

The vestries, on the other hand, have been guided by the most narrow parochial reasons. They have forced tramways to come to an end at ridiculously inconvenient places, and in some cases have positively refused to allow any tramways at all, lest they should have workingmen on tramcars passing through select streets on their way to and from homes in remote suburbs. Yet there is no power under the tramways act to overrule such selfishness in the interest of the greatest number, and the London county council now finds itself blocked by it just as private promoters have been.

In the second place, there is no power under the tramways act to take land compulsorily for street-widening or for the making of new streets or roads along which the tramway is to run. Except for the limited powers in London under Michael Angelo Taylor's act, local authorities likewise have no power to take land for such purposes without special parliamentary authorization, and it was not to be expected that parliament would give greater facilities to a tramway promoter than to a local authority. I venture to contend that the power should be given to both. Barring roads made under special turnpike acts, English roads have been laid out by individual landowners solely for the benefit of their own estates. I believe that in many cases the landowners have purposely made the roads narrow and inconvenient as thoroughfares, to prevent the country beyond from being readily developed for building. Apart from set purpose, numbers of country lanes or village streets have become, as it were by accident, main thoroughfares. To fit them for tramways, widenings are necessary, while in remoter districts it would often be cheaper to make new, straight roads through the fields with a central electric railway. Under the tramways act all this is impossible.

In the third place, the tramways act provided that the tramway should be in the middle of the road, whereas along a blank wall the side of the road is often the most convenient place ; and it was not to be authorized if for 30 feet the distance between the outer rail and the curb was less than 9½ feet and one-third of the owners or occupiers abutting objected. This provision has had the most disastrous results. Many lines of great public utility have been blocked entirely by frontagers. Others have been made as single lines, where they ought to have been double.

In the fourth place, the promoters were placed under the obligation of repairing the road between the rails and for eighteen inches on each side. This has proved a most unfortunate provision. Constant bickerings have arisen with local authorities. The local authority may change the paving of the rest of the street from stone to wood, but has no power to insist that the tramway company shall follow its example. The tramway company, having regard to the purchase clause, has often refused to make any change. It may or may not be just to compel a tramway company to contribute more than an omnibus company to the upkeep of the roads, though, where the motive power is electricity, it touches no part of the road except the rails. But, whatever contribution is fairly required should be in money, and not in work, so as to avoid, as far as possible, the disadvantage of a dual authority over the roads.

But the most serious defect of the act is the purchase clause. Under clause 43 the local authority has power to buy the undertaking at the end of twenty-one years, "upon terms of paying the then value (exclusive of any allowance for past or future profits of the undertaking, or any compensation for compulsory sale, or other consideration whatever) of the tramway." As this clause has now been interpreted, it means that the company will get the proper cost of promotion and construction,* less an allowance for depreciation. The price is not, in strict language, "old-iron value," but it is something much less than the actual value of the undertaking, if that undertaking has been successful. The forty-third section has enabled the local authorities to acquire some flourishing enterprises at a very low price, but it has had other incidental effects, upon which its framers scarcely calculated. From the first it discouraged the best class of capitalist—the capitalist, that is to say, who is content with the lowest return—from investing in tramway undertakings. Small investors were attracted by the higher rate of interest, but, when they found out what the purchase clause meant, they refused to invest any more money in new tramways. The directors and managers, having nothing to gain by building up a good permanent business, ran the concerns with a view merely to immediate profits. During the last seven or eight years of the twenty-one they made scarcely any improvements, and it has so happened that during the last decade all the rest of the world has been adopting electricity. Thus the tramways act of 1870 is the principal reason why English workingmen enjoy so few facilities for cheap street transit. For many years past scarcely any lines have been promoted under it, except by municipal corporations, whose undertakings cannot be compulsorily purchased.

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* Though cases as to the interpretation of what Lord Herschell called the "not very felicitous" language of the act went twice to the House of Lords, one point seems to me to have been left in some doubt,—*viz.*, whether the arbitrator is to take into account the actual cost of promotion and construction, or what the cost would be at the time of purchase. Apparently the Edinburgh arbitrator took the actual cost of promotion as the test of the promotion allowance, but both he and Sir Frederick Bramwell refrained from explaining how they arrived at the proper cost of construction, and the judges did not enter into that question. It may, in my opinion, be very strongly contended that, though the cost of construction has perhaps remained, on the whole, about the same, the cost of promotion has very much increased. Thus, when the county council tries now to get the road authorities to assent to new tramways, they ask that the council should assume the whole cost, not merely of repairing, but even of lighting the road, and, if any of the principal existing tramways were to be promoted afresh, the vestries would doubtless insist on some such payments. The county council, in acquiring the existing undertaking, acquires it free from obligations so onerous, and, when estimating the cost of promotion as part of the "then value of the tramway," the arbitrator should make a capital allowance for the saving which the county council makes through the forethought of the promoters in obtaining powers before the greed of the road authorities got to its present pitch. I hope that this point will be argued in some future case.

III. Even corporations, however, find the restrictions of the tramways act tedious, and many of them, caring little for the possibility of greater expense, have recently proceeded by separate private bill. It may be asked why the promoter should not ignore the tramways act and go for a tramway bill as he would for a railway bill. The answer is threefold. In the first place, parliament, having provided the procedure by provisional order, discourages applications in any other way, unless it can be clearly shown that the scheme involves things which can not be done under the tramways act,—*e. g.*, the compulsory acquisition of land. Secondly, the standing orders of parliament make the consent of the road authority an absolute condition precedent, and this standing order is seldom, if ever, suspended. The local authorities in many cases are so enamoured of the prospect of buying up the tramway cheap at the end of twenty-one years that they will not consent to the bill unless the purchase clause of the act of 1870 is inserted. They may, in the course of years, realize how short-sighted this policy is, but in the meantime they are content with the stereotyped answer: "We must not alienate our roads"—as if roads were made to be looked at and not to be used by the greatest number at the quickest pace and the cheapest price which scientific improvements permit. In the third place, a private bill is necessarily expensive, and most tramway schemes will not bear to be overloaded with promotion money.

IV. Parliament has now provided, under the light railways act of 1896, a new procedure, which has great possibilities. The light railway commissioners have, in theory at least, great powers. After holding a local inquiry, they may, with the consent of the board of trade, authorize a light railway anywhere, wholly on the roads, or partly on the roads and partly on private land and partly on roadside waste. They may allow land to be taken compulsorily to widen a road along which the railway is to be run, or for the railway itself, though they may not allow sufficient land to be taken to make a new road. The railway may be worked by any motive power, and may be, to all intents and purposes, an urban tramway. The consent of the local authority or of frontagers is not required.

As yet, however, the light railway commissioners have shown a perhaps not unnatural hesitation in exercising their powers. They have, it is true, overruled generally the very absurd objection that the act was not to apply to towns. The House of Commons had fair warning that road railways were contemplated. Thus Mr. Ritchie, in introducing the bill, referred to the Belgian light railways as "a great system of steam tramways. The main roads were used for the lines, although occasionally a strip of land by the side of the road was taken, or a short cut across country was made." He then went on to show that the Belgian system was better than the French (Hansard, 4th series, vol. 37, p. 738). In the House of Lords Lord Welby, acting on behalf of the London county council, moved to insert a provision making it necessary for the order, when objected to by a county council, to be confirmed by parliament. "The noble lord said that the house would observe that in the bill there was no definition of 'light railway,' and he understood that the provisions of the bill applied, and were intended to apply, to tramways in towns. . . . . His attention was drawn to the clause as a member of the London county council, but he made no distinction between London and other towns in this respect." The amendment was opposed by Lord Salisbury, and rejected by 79 to 31. It is idle, therefore, to deny that the act was intended to apply to road lines, and even to road lines in London, and the commissioners have, on this general question, clearly expressed their view.

But in practice they do not feel able to override the local authority, except in very strong cases. On the other hand, the commissioners do not feel bound to grant powers simply because the local authority consents. Thus at Hastings they refused powers, because a minority in the corporation, none of whom lived on the line of route, objected strongly. The minority produced evidence to show that distinguished physicians, including Sir Samuel Wilkes, the president of the College of Physicians, regarded electric tramways as injurious to the health of invalids, and the commissioners did not feel justified in granting powers where a considerable minority of the population were so strongly prejudiced against the proposal. Thus the light railway act has not yet been quite so fruitful of new powers as promoters had hoped. Doubtless Lord Jersey, who, with conspicuous self-sacrifice, gives nearly his whole time to the work without fee or reward, is anxious not to move in advance of public opinion, and it cannot be denied that a very large number, in the upper middle classes especially, are opposed to tramways of all kinds. I do not believe that this feeling will be quickly eradicated. The dweller in Hampstead enjoys exceptional advantages, because he is within the four-mile circle from Charing Cross, but within a mile or less of open country. He pays at the rate of £5,000 an acre for freehold land, partly because of this exceptional advantage. A mile further out equally good land can be got for £500, two miles further for £150, an acre; but the building will not go in advance of the means of communication. To the Hampstead owner or occupier it is a matter of supreme importance that the land beyond should not become available for the homes of the workers in the West End of London. So he hates, and always will hate, tramways. The worst of it is that, if the light railway commissioners were to overrule this sort of villa-owner's selfishness, they might find themselves without any backing from those who are supposed to represent the workers, but who mutter "monopoly!" when any private investor attempts to do anything, and fancy that in that one term of abuse they have summed up all political wisdom.

I do not doubt that eventually the light railways act will prove to be the best means of promoting electric-traction schemes. The worst of it is that every year is precious, and that every year enormous improvements are being made in every country but England. I venture to suggest that, to facilitate the adoption of electric traction under the light railways act, certain amendments of the act are desirable. They are not very revolutionary, but I believe they would be useful.

1. I believe it would be well to give the commissioners express power to incorporate any of the provisions of the tramways act, with or without modification. They incorporate many provisions already, but an express reference to the act might soothe local authorities.

2. If electric-lighting powers could be granted by the same order, some expense would be saved, while many of the richer people who oppose traction schemes might be attracted by the prospect of electric light in places where it would not be commercially possible apart from traction.

3. It is very desirable that the commissioners should be able to authorize the taking of fore-courts or a slice of garden for road-widening, without purchase of the whole property, under section 92 of the lands clauses act.

4. I see no reason why, when land is taken for a railway, enough should not be taken to make a road, along which the railway or tramway would run. This would be to the interest of the land-owner whose land would be opened up for building, but some land-owners oppose every change. Sometimes the railway might run between trees in the centre of the road, except for occasional crossing-places.

Thus we might have a foot-path, a road twenty-five feet wide, a row of poplars, a double line of tramway, another row of poplars, and another twenty-five-foot road. The tramway track need not be paved, except at crossing-places, and thus something would be saved in construction and maintenance,—perhaps nearly enough to buy the extra land,—while the freedom from obstruction would allow rapid running. No one can doubt that a main road laid out in that way would soon be built upon, while the objection of the carriage folk would be reduced to a minimum. If the promoter has security of tenure (which he gets under the light railways act), he can bear the increased expense, and the advantage of the security is thus reaped by the public.

5. The board of trade is authorized by the act only to appoint a single paid commissioner, and his salary is not to exceed £1,000 a year. If the work grows, as seems probable, further paid assistance will clearly be required.

Curiously enough, no municipality has yet proceeded to obtain powers to construct a line under the light railways act. The reason for this is very simple. The old objection to socialism—that it means new and crude experiments at the public expense—is almost entirely groundless. The real danger is in the opposite direction. The town councillor or county councillor does not like to risk the ratepayers' money in experiments which will not fructify until long after the next municipal election. It is because tramways have been made the subject of an experiment in municipal socialism that England is ten years behind the rest of the world in electric traction. It is true that the municipalities are now, in some cases, adopting electric traction on the lines they have bought so cheaply. Probably in a year or two they will be boasting of their success. But no mere money-saving in the cost of acquiring the existing lines will compensate for ten years of delay, ten years of slum life for children who, but for the tramways act, might have been brought up among healthy surroundings, ten years of comparative stagnation in the electrical-engineering trade, while the greatest of the new industries of the century has become almost the monopoly of the great republic which has been liberal enough to give free play to private enterprise and democratic enough to see that the people got facilities for cheap transit on free streets.

I understand that in America some learned professors have been pointing to the English examples as evidence of what benefit can be derived from the chary grant of franchises. But the municipalities which granted franchises readily had a much wider understanding of the needs of the public than the professors.

EFFECTIVE SYSTEMS OF FINDING AND KEEPING SHOP COSTS.

By Henry Roland.

THE NATIONAL SWITCH AND SIGNAL COMPANY'S METHODS.

THE cost-keeping system of the company whose methods form the topic of this paper was devised by Mr. Chas. Hansel, vice president and general manager, who has kindly, if reluctantly, consented to this necessarily brief description. The system is adapted to any number of factory departments and workmen, and is designed throughout with a view to the accuracy of detail and exact knowledge of flat, factory, and installation costs which is forced by the close competition in this branch of manufacture.

These costs are gathered primarily by cards and recorded finally in books, the books being introduced for differential expositions of the costs, so that comparisons of successive results are forced upon the attention of the manager. The inventory is made monthly, and the system unquestionably presents the possibility of a very close approximation to accurate cost-keeping. A system of specifying all accounts by numbers, called "Key to Distribution of Voucher," avoids all possibility of conveying information of actual performances and results to any one not in possession of this key. The first ten numbers are devoted to voucher titles, under the general head of "Advertising," sub-divided into (1) "catalogues and pamphlets, ledger page 1"; (2) "journal cards, page 2"; (3) "exhibits, ledger page 3"; (4) "photographs, page 4"; (5) "entertainment, page 5." The remaining four numbers of the subdivision, 6, 7, 8, and 9, are as yet unfilled. The next seven numbers of the main division are devoted to realty and buildings accounts, under the general title of "Buildings and Lands," the separate item accounts being posted on ledger pages 9 to 13 inclusive. Nos. 18 to 24 cover the divided accounts, grouped together under the general title of "Draughting"; Nos. 25 to 34, inclusive, are under the general title of "Experimental"; Nos. 35 to 50, inclusive, cover the various divisions of the "Factory Pay-roll," divided as follows: "blacksmith productive, blacksmith non-productive, electrical productive, electrical non-productive, foundry productive, machine shop productive, machine shop non-productive, wood shop productive, wood shop non-productive, shipping department productive, shipping department non-productive." This list of pay-roll distributions will give the expert accountant a fair idea of the minute subdivisions of the prime cost and expense accounts. In all there are 149 sub-accounts, under 24 general voucher titles, in actual existence on the ledger under number symbols.

As the factory operations of the National Switch and Signal Company include at least seven well-defined departments,—designing, wood-working, machine construction, drop forging, blacksmithing, founding, and installation,—it follows that a sufficient system of factory-accounting for this establishment is very likely to cover the needs of a great majority of manufactories in general. While these 149 sub-accounts may seem at first sight burdensome, especially in case of a small factory, they are, on the contrary, labor saving.

To illustrate, suppose a boy were required to sort a pile of machine-shop scrap containing 149 different things; then, if the boy was provided at the outset with 149 boxes, each having a sample article attached, he would sort the pile correctly and without difficulty. If he had a smaller number of boxes, he would often be in uncertainty as to the correct place for a piece he had in his hand. Precisely the same is true of accounting. When Mr. Hansel completed this cost-keeping system, he believed it would produce accurate results, but he feared it would prove too heavy for the works. The system was installed, and gave correct results, and the cost for the first year was $135 *less* than the cost of cost-keeping the previous year with a makeshift system, which was tolerated only because it was simple, inasmuch as it had few accounts, and was supposed to be inexpensive, because things were lumped and guessed at, at the expense of accuracy.

In the Hansel system, three costs are kept,—the flat cost (including labor and material only), the factory cost (factory expense added to flat cost), and total cost (including all expenses of every kind).

The factory expense account was originally charged to no less than 84 separate job numbers, beginning with Job No. 1, engine driver's time, and ending with Job No. 84, machine-shop-helper's time not directly chargeable to any shop order. These 84 standing job numbers include labor and material for different shop repairs, sweeping, handling stores, cupola tending, and coremaking, and are intended to include and separate all items of expense not directly chargeable to any productive order number.

This schedule of expense divisions is as follows, covering labor and materials for which no regular production order is issued. Division No. 1, engine driver's time; 2, engine room supplies; 3, watchman's time; 4, sweeping and cleaning machine shop; 5, same, electrical department; 6, same, foundry; 7, same, wood shop; 8, same, blacksmith shop; 9, 10, 11, 12, and 13, oiling shafting, machine shop, electrical shop, foundry, wood shop, and blacksmith shop; 14, 15, 16, unloading coal for blacksmith shop, boilers, and pig-iron, coke, sand, and coal for foundry; 17, setting up new machines in factory; 18, starting new machines in work; 19, materials for machine-shop tools; 20, labor on same; 21, 22, same, electrical shop; 23, 24, same, foundry; 25, 26, same, wood shop; 27, 28, same, blacksmith shop; 29, materials for building repairs, drains, fences, tracks, and sidewalks; 30, same, labor; 31, 32, material for machine repairs and renewals, and labor on same; 33, 34, same, electric department; 35, 36, same, foundry; 37, 38, same, wood shop; 39, 40, same, blacksmith shop; 41, 42, material and labor for pattern repairs; 43, 44, same, flasks; 45, 46, same, "floating equipment" (meaning the tools used in erecting outside of the factory: a fixed charge of $20.00 is made for loss, breakage, and depreciation on each "floating plant" each time it is issued); 47, 48, material and labor to put in order stores returned from contract installations; 49, 50, material and labor for boxing other than contracts; 51, 52, material and labor repairs of office furniture; 53, 54, material and labor to repair jigs and templets, machine-shop; 55, 56, same, electric department; 57, 58, same, wood shop; 59, 60, same, blacksmith shop (new formers, jigs, and templates are made only on production orders issued by the superintendent); 61, unloading and handling stores; 62, handling "Bushnell work" (delivery to them); 63, 64, materials and labor repairs to building No. 1; 65, 66, same, building No. 2; 67, 68, same, building No. 3; 69, 70, same, building No. 4; 71, 72, material and labor to repair fixtures in machine-shop (meaning furniture, fittings, heating appliances, benches, and shelving"); 73, 74, same, electric department; 75, 76, same, foundry; 77, 78, same, wood shop; 79, 80, same, blacksmith shop; 81, core maker, foundry; 82, cupola tender; 83, foundry labor in grinding and cleaning castings, etc.; 84, helper in machine shop.

The printed forms used are given below. To save space the text and size of each form are given, without attempting, as in previous papers, to show the actual style of the text on the printed form.

Form No. 1. Requisition to purchase. This is approved at manager's office, issued to purchasing agent, and returned to accounting department for filing and check against invoice. Two sizes; small, 8½ inches by 5 inches; large, 8½ inches by 10 inches. Text:

Date .... Requisition to Purchase. P. A. Order No..........
To Purchasing Agent: Date ordered.........................
You are hereby requested to purchase the following described articles to be delivered to............................. Ship via...........................

Quantity.	Description.	Remarks.

Approved. .. .. Gen. Manager. Approved.... ....Supt.

Form 2 : small, 7 inches by 6 inches; large, 7 inches by 12 inches.

Superintendent's order on Storekeeper.

Order No............

Contract No............ Date...............

Quantity.	Catalog No.	Description.	Remarks
....	....	....	....

Directions.

Date wanted...................

Ship to.........................

At..............................

Ship via........................

....

Superintendent.

Return Memorandum.

Date Shipped		Initial Car.	No. Car.	Remarks.
....				
Month	Day	....	......	....
......	......	....	......	....

....

Storekeeper.

It will be observed that each order has two numbers, the "shop production" order number and the "contract" order number, or, in other words, a selling order number and a shop order number.

Form 3 : size, 7 inches by 5 inches.

Stores Memorandum.

Date................

On hand.	Required.	Description.	Remarks.
....	....	....	....

This form is used by the stores keeper to give the superintendent advance information of stores requiring replenishment in the near future.

Form 4. Superintendent's requisition on factory. Size: small, 6 inches square; large, 6 inches wide by 12 inches high.

Superintendent's Requisition on Factory,

Requisition No............ ... Date............ ...

For Sales Order No................

Quantity.	Catalog No.	Plan No.	When required.		Remarks.
			Month	Day	
....	....	....	......	......	....

To............................

You are hereby instructed to furnish the above stores, and report when same are ready for delivery.

....

Superintendent.

The above requisition is complete and ready for delivery.

Dated.... ....

....

Foreman.

This is used either for production order or for sales order. If used for sales order, the number of the superintendent's order on the storekeeper, form No. 2, will be entered on the form after the words "Sales Order No........".

Form 5. This is a bound book, each line of each page covering the principal records of one "order number,"—that is, one single production order, or sales order, in the factory. The width of the page is 14 inches. The up-and-down dimension may be as desired. Each page is headed, in bold type: "Prime Cost Record." Then follows this horizontal line of column heads:

"Order No. Catalog No. Description. Quantity. Weight. Dimensions. Material Used. Non-productive Material. Non-Productive Labor. Royalty. Other Disbursements. Total Expenditure. Average Cost Each. Date Finished. Month. Day."

From the "Average Cost Each" column, the stores keeper enters "prime" costs in Orders Account Book, when any Sales order is filled from stores on hand in the stores room. This column also gives instant information as to the cost of the *last* order of a certain article made, and, of course, forces constant comparisons of successive-order costs of the same article.

Workmen use a mechanical time-recorder requiring the vibration of a lever on entering and leaving the shop. In addition to this record, each workman perforates a five-minute time-card for each job on which he is employed, simply piercing the card at the five-minute points most nearly representing his times of beginning and ending work on the job in hand, the appropriate order number being entered on the card by the foreman. A separate card is used for each order worked on. When the workman enters the shop in the morning, he is furnished with one time-card, which he hangs on the upper hook

TIME CARD.

Workman No............ Date..................

	H.	MIN.										
Date Commenced..............	7	5	10	15	20	25	30	35	40	45	50	55
	8	5	10	15	20	25	30	35	40	45	50	55
Order No....................	9	5	10	15	20	25	30	35	40	45	50	55
	10	5	10	15	20	25	30	35	40	45	50	55
Catalogue No................	11	5	10	15	20	25	30	35	40	45	50	55
	12	5	10	15	20	25	30	35	40	45	50	55
Number Pieces...............	1	5	10	15	20	25	30	35	40	45	50	55
	2	5	10	15	20	25	30	35	40	45	50	55
Operation No................	3	5	10	15	20	25	30	35	40	45	50	55
	4	5	10	15	20	25	30	35	40	45	50	55
Date Finished...............	5	5	10	15	20	25	30	35	40	45	50	55
	6	5	10	15	20	25	30	35	40	45	50	55

Approved,

....

Foreman.

in his individual time-board, after perforating it at his beginning time. When the job is completed, the card is transferred to the lower hook. The time-cards on the lower hook are removed by the time keeper each morning, cards on the upper hook being left undisturbed. The style of the card, which is 4½ inches square, is given on the preceding page.

This time-card was first used with fifteen-minute divisions. After the cards are collected, the individual totals are compared with the clock record, made to agree therewith, and filed after charging the time to proper orders. Time is paid on the clock record only.

Form 7 is a book, having pages 14 inches wide, headed in bold type "Wages Record," below which is one line of column headings:

Name. No. Dept. Trade. Date engaged—Month, day. Date dismissed—Month, day. Rate per hour. Advanced—Date, month, day, rate. Advanced—Date, month, day, rate. Remarks.

This forms the cost clerk's authority for labor value in prime costs.

Form 8. Time sheet. This is a book form, each page being 14⅞ inches wide, and headed in bold type. "Time for Two Weeks Ending........189.." Below this is a single line of column heads:

Name. No. Depart. Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday. Distribution as shown by workman's time-card: Hours productive. Hours non-productive. Hour rate. Total productive. Total non-productive. Total due. Remarks.

Each workman is given part of a page, or a whole page, so as to show his time on each order on a separate line.

Form 9 is likewise a book, having pages 14 inches wide, each headed in bold type: "Piece Work Time Book. For Two Weeks Ending..............189.."

Below this is one line of column headings as follows:

Name.	No.	Dept.	Catalog. No.	Pattern No.	Quantity.

Rate per piece.	Total.	Comparison Time and Piece Work.			
		Total Hours.	Rate per Hour.	Difference.	
				By hour.	By piece.

Remarks.

Time is transferred from form 8 to form 9 to show comparative value at given hour-rate as compared with piece-rate.

Form 10 is the Piece-Rate Book. The pages are 10½ inches wide, headed in bold type. "Work Rate Book," followed by a single line of column headings as follows:

Catalog. No. Description. Size. Pattern No. Weight, Lbs. Rate per piece. Authorized by...............

The rate on each article is fixed by manager or superintendent.

Form 11. Department requisition. Size, 6 inches square, in different tints for different departments. Text as follows:

Department Requisition on Stores. The following stores are required on account of Supt's. order No...... Job No...... Date........

Then comes this line of column headings: Quantity. Description. Weight. Remarks. At the foot are two lines of text: Received ....Foreman. By order of ....Foreman.

These orders are entered on the "Disbursing Ledger." The orders are manifolded. The original is delivered to prime cost clerk with "prime" cost of all stores issued thereupon, and the order number is debited accordingly.

Form 12 is a department credit memorandum to stores, size 6 inches square, on differently-tinted papers, text as follows:

Department Credit Memorandum to Stores. Credit order No ...... Job No. ...... with following stores delivered........ ... ...

Then follows this line of column headings: "Quantity. Description. Weight. Condition. Remarks. The text at the foot of this form reads as follows: Above stores received..........Store Keeper. To Store Keeper: Please acknowledge rect. of above described stores ....Foreman."

This is for returning stores drawn for an order, but not used.

Forms 13 and 14 are a Stores Ledger, in which are recorded all receipts and disbursements of material and stock, made on whatever order. The stores received represent all stock or material received, whether from without, by purchase, or from within, by production. If purchased, values are fixed by purchasing agent from invoices, with 5 per cent. added as shop charges; if produced, values are "prime" cost, or flat cost with certain factory expense additions. This ledger shows stock and material on hand. Two ledgers are kept, one for finished stores and one for rough stores. The stores room, under this system, becomes a "clearing house" for the entire factory.

Form 15. "Stores Received Record." Two sizes: small, 6 inches square; large, 6 inches wide by 12 inches high. This form is used as a tally sheet by the stores keeper in receiving, and is as follows:

Stores Received Record. Date .... The following articles have been received in good order and deposited in Bin No......

Following is this line of column headings: "Car Initial. Car No. Description." At the foot: "Received and reported by."

Form 16, "Stores Rejected," is used to register articles received in bad order, or for any other reason rejected. It is attached to Form 15, and both are returned with invoice to purchasing agent. Color, pink; size, 6 inches square. Text as follows:

"Date .... Stores Rejected Report.
To Store Keeper: The following articles have been received in BAD order and rejected. Please give instructions for disposition."

Then follows this line of column headings: "Car Initial. Car No. Description." The foot line is: "Rejected by.............."

Form 17, "Stores Returned Memorandum." Size, 7¾ inches by 6 inches. The line of column headings reads:

Date Shipped		Date Returned.		Shipped on Order No.	Description.	Prime Cost and handl'g.	Return Value.	Loss.
Month	Day.	Month	Day.					

This form has no foot-line. Such return stores are charged to stores room at return value, and credited to the original sales order. The bill clerk is authorized to render a corrected bill.

Form 18. Head line, "Daily Cupola Record;" size, 5 inches by 8 inches. Column heads: "Materials. Lbs. Price. Total."

The left-hand vertical column is filled as follows: "Watts, Niagara, Shenandoah, Silicon," on successive lines; then follow five vacant lines; next come "general scrap," "gate scrap," on separate lines, followed by three vacant spaces; and the last three lines are filled by "coal," "coke," "wood." The return shown on this form is entered on the monthly report sheet, and from this record the gross cupola cost of castings is established. Adding foundry pay-roll total and supplies-cost total gives castings production cost, charged to foundry, and foundry is credited with all castings received by stores room at a rate per pound fixed by above totals. The pound rate may vary from month to month; 5 per cent. is added to foundry pound rate for stores room value of castings.

Form 19. Fuel Record book; width of page, 9½ inches. Each page printed with bold headline, "Fuel Record," followed by "Name of Department using ....," and then a line of column headings; "Date Received. From whom purchased. Price at Mine. Freight. Handling. Total Cost. Per ton. On Hand. Date. Tons."

Fuel cost is a general operating expense, except where charged directly to blacksmith, drop forging, and foundry. The distribution of fuel is specified as far as possible, leaving little outside of power and heating to be charged to general expense.

Form 20. Handling Record. Size, 5½ inches wide by 6 inches high. Bold headline, "Cost of Handling." Second line reads:

Department............ Date............. 18 .....

Car initial.	Car No.	Date Rec'd.		No of Man.	Total Hours.	Rate per Hour.	Total Charge.
		Month.	Day.				

On this form is printed at the foot:

This blank must be filled out and fastened to invoices for carload lots or less if ordered, and signed by person in charge of unloading........................

This form is used to show direct charges arising from handling fuel, lumber, signal poles, and material in car-load lots. All other labor consumed in handling goods, either in receiving or distributing, is charged as unproductive, and all labor noted on form 20 is charged directly to invoice or production order, as the case may be.

Form 21, "Building Record," is used to register size, description, and value of all buildings included in the works, and contains original costs, and costs of renewals and repairs. Depreciation deducted at stated periods, making this form show present values.

Form 22. "Machinery Record." This form records the economic history of each machine used in the factory. It is not intended to contain an account with each machine, showing expenditures for repairs and renewals, as such charges are at present included in "unproductive labor and material," or else charged directly to machine rate per hour in prime-cost record. This form is a book, having pages 15 inches wide, headed in bold type: "Record of Machinery." The line of column headings is as follows:

No. Name of machine. Maker. From whom purchased. Date purchased. Purchase value. Weight. Cost of Freight and handling. Cost of installing. Total cost. Charged off for depreciation. Value. Date.

Form 23. "Shipping List." This form, when filled, is compared with the customer's order and with the production order, signed by the clerk making the comparison, and delivered to the superintendent's office. Size: small, 8½ inches wide by 6 inches high; large, 12 inches high. Headed "Shipping List"; second line, "Stores shipped by the National Switch and Signal Co." Third line, "Easton, Pa., ... 189....." The following five lines are:

Car No.... .... Via............
Car initial... .... To.. ....
Order No............
R. R. Order No.............
For Plant at............ Checked with R. R. order by...........

The column head line reads:

Description of Package. Quantity. Catalogue No. Articles. Value.

Form 24. "Pattern Record." The right-hand column of this form shows whether the prime cost has been charged against any specific order. If not, it is charged as unproductive labor to general expense. When filled, this form constitutes an important estimating reference. The page is 9½ inches wide, headed in bold type: "Pattern Record," followed by a line of column headings:

Description. Date made. Drawing. No. Material. No. made. Follow boards. Flasks No. Flasks size. Cost material. Cost labor. Total cost. Charge to order No....

Form 25 is similar to form 24, and of the same size; pages headed in bold type: "Jigs, Dies, and Special Tools Record," followed by this column head line:

Description. When made. Kind of material. For what purpose. Weight. Cost of material. Cost of labor. Total cost. Charged to order No....

Form 26. Voucher. Size, 9 inches wide by 8 inches high. Printed on face as follows: first line, "Easton, Pa.,......... 18..." Then

The National Switch and Signal Co.,
To......................... Dr.........
18.... Address.................................. ....

The body of the voucher is ruled in a narrow vertical column headed "Key," at the left, containing the "Key" number of account chargeable, with adjacent dollars-and-cents columns; at the right are double dollars-and-cents columns; at the bottom:

Approved for payment
........................V. P. and Gen'l Mgr.

"I certify that I have examined all extensions, prices, and calculations, and find them correct, and have entered the account on the books of the company, and the same has not been previously paid. .... Treas. and Pur. Agt.

Further below is the receipt form:

Rec'd .... 18.., from the National Switch and Signal Company, ... $\frac{}{100}$ dollars in full for above account.

(Sign here) ....

Note. The above receipt must be dated and signed by the party in whose favor this voucher is made, and returned to the TREASURER, THE NATIONAL SWITCH & SIGNAL CO., EASTON, PA.

This "Voucher" form is used to record all disbursements of cash, except for factory and piece-work pay-rolls. The distribution of disbursements is grouped under 24 general divisions, called voucher titles. These voucher titles are not shown on the ledger, but each receives a number under which all subdivisions are registered, and the ledger account with each subdivision is numbered with the voucher-title number. The voucher form is printed on white paper for the office, and on tinted green paper for the agents.

The "Key" to this voucher number shows the title and number of subdivisions under each voucher title, so that at any time the subdivision account can be determined by the "Key" number.

On the back of the voucher is the following, followed by blank lines numbered up to 35, with one double-ruled space for totals at the bottom:

Voucher No...... Check No......
Favor of...... ....
Address........... ....
For...................
At....................
Month of .... 18...
Amount $...........

General Distribution.	Key.	Amount.

1. Advertising.
2. Buildings and Lands.
3. Draughting.
4. Experimental.
5. Factory pay roll.
6. Fixture acc.
7. Freight.
8. Fuel.
9. General expense.
10. Hand tools and supplies.
11. Installation.
12. Interest and discount.
13. Jigs and dies.
14. Law.
15. Machinery.
16. Maintenance, Buildings, and Lands.
17. Merchandise.
18. Oil and waste.
19. Operating.
20. Patents and good will.
21. Patterns.
22. Petty Cash Accounts.
23. Rent.
24. Trading Account.”

Form 27, “Pay Roll Voucher.” This has the same distribution of voucher titles and subdivisions. Size: small, 12 inches by 9 inches; large, 12 inches by 18 inches; printed as follows:

The National Switch and Signal Co. Pay roll for ...... weeks, ending........
Voucher No. .... Place .... Sheet No....”

Then follows this line of columns:

Name. No. Dept. Rate per hour. Hours productive. Hours non-productive. Total hours. Amount. Reductions. Amount paid. Date paid. By whom received.”

Then follow fifteen blank lines, numbered consecutively in small characters at the extreme right-hand and left-hand margins. The printing at the foot is in three vertical divisions, as follows:

I certify that the above mentioned persons were employed as shown, and that the respective amounts are due them as set forth. .... Superintendent.
Approved for payment .... V. P. and Gen'l Mg'r.
Paid as shown above .... Sec'y and Treas.

This “Pay Roll Voucher,” form 27, has on its back the vertical column of key numbers previously given for the general voucher form No. 26. The “Pay Roll Voucher” must be signed by all persons registered thereon, wherever employed. Different tints of paper are used for factory and installation workmen.

Form 28, “Piece Work Pay Roll,” is similar to form 27, the variation being in the line of column headings, which reads:

Name. No. Pat. No. No. pieces. Rate per piece. Total. Grand total. Deductions. Amount paid. Date paid. By whom received.

Form 29. "Voucher Register." This is a book, having pages 35⅝ inches wide, with this headline in bold type:

The National Switch and Signal Company. Vouchers registered month of .... 189..

Then follows this line of column headings:

Voucher No. Check No. To whom issued. Date paid. Amount. Key No. Advertising. Buildings and lands, Draughting. Experimental. Factory pay roll. Fixtures. Freight. Fuel. General expense. Hand tools and supplies. (Fold | here.) Installation. Interest and discount. Jigs and dies. Law expenses. Machinery. Maintenance B. and L. Merchandise. Oil and waste. Operating. Patents and good will. Patterns. Petty cash accounts. Rent. Trading account. Total. Date voucher returned.

Form 30. "Address Slip." Enclosed with all vouchers sent out by the treasurer, for ensuring accuracy of address in returning.

With a system of minutely-subdivided cost-keeping, "estimating" becomes purely mechanical, demanding, instead of unusual powers of memory and foresight, only ordinary clerical ability. Here follow the totals of five consecutive estimates with their actual costs, taken at random from the file of contract synopsis cards.

Estimated Cost.	Actual Cost.
$2307.00	$2297.00
837.00	801.00
1606.00	1567.00
1521.00	1588.00
1153.00	1127.00

Each of these estimates includes installation of the plant sold; this installation is an out-door job, subject to variations due to soil, accessibility, and the weather. The installation cost is a matter of estimate,—a guess, founded on past experience; in most cases the installation estimate is high; in this one case it is low, thus showing the impossibility of accurate guess-work, even when the guesser has had large experience in the line which forms the subject of speculation.

The factory manager accustomed to "lumping" methods of cost-keeping, who has followed this paper so far, probably approves the accuracy attainable, but believes so minutely-detailed a system of cost-keeping impracticable, because of the clerical labor involved. Such a belief is excusable, since Mr. Hansel himself was in doubt as to the propriety of installing his system, after spending his spare time for a year in devising it, in consultation with President Thorne.

With a high pay-roll of something like 500 names, a large part of them outside of the factory, and with daily detailed factory reports, bi-monthly balance sheets, and monthly inventories, all of the cost keeping is done by one cost-keeper, one assistant, and a typewriter.

THE DARIEN GOLD-MINING REGION IN COLOMBIA.

By Eduardo J. Chibas.

THE region of Darien, extending from the Atlantic to the Pacific, forms the southeastern portion of the isthmus of Panama, in the Republic of Colombia. It was from this region, so full of historic interest, that Vasco Nuñez de Balboa discovered the Pacific ocean in September, 1513. Balboa obtained considerable gold from the Indians at that time, and, although he wrote to Spain that he had discovered in Darien more than thirty streams carrying gold, it was not till more than a century later that any attempts were made at gold mining. The quick returns, and the abundance with which gold was found as soon as mining was started, encouraged the Spaniards to brave the unknown perils of the virgin forest inhabited by warlike Indians, some of whom have, to this day, remained unconquered and still occupy and hold sway over a small portion of the territory. The early settlers were repaid for the untold hardships of travel and climate they had undergone by the discovery of the Espíritu Santo mine, in Cana, which alone produced more than $30,000,000 in gold.* This mine was successfully worked from 1680 till 1727, when a general revolt of the Indians obliged the Spaniards to be constantly on the defensive, and made it very difficult for them to continue operations. Matters were aggravated by the falling-in of one of the main galleries, causing the loss of several lives and hastening the complete withdrawal of the Spaniards from the gold region. No serious attempts were made to renew operations till a century and a half later, when an American company was organized with New York capital. They spent about $50,000 in opening a road and buying and transporting machinery, but, being unable to secure additional capital, they had to abandon the scheme in 1880, before any actual mining had been undertaken. The matter was again taken up in 1888, and, by the efforts of Mr. Hammersley Heenan, of Manchester, England, the Darien Gold-Mining Company was organized, in that city, with a capital of $1,000,000. Its object was to locate the Espíritu Santo mine, and to take up the work where the Spaniards had left off. Innumerable difficulties surrounded the enterprise at its inception. The mines of this region had remained untouched for nearly two centuries. A forest had grown on the site of the old mining town, near Cana, which at one time must have been well defended, as in the ruins of one of its forts three brass cannons were found. Old workings could be seen in the beds of many streams, or near them, where the alluvial deposits had been worked. Remnants of old stone stamp heads and long and deep water ditches added to the evidence of the industry and activity displayed by the early settlers in that region.

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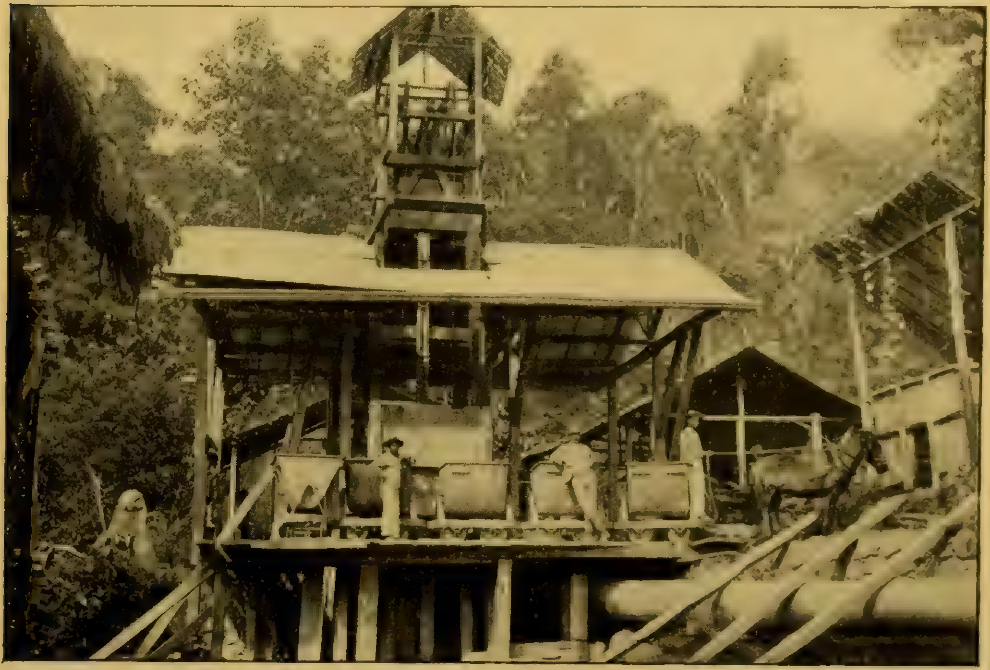
* "Estudio sobre las Minas de Oro y plata de Colombia," por Vicente Restrepo. Bogotá. 1888.

But the ancient records were somewhat confusing as to the exact location of the richest mine, and, in consequence, a few of the old workings had to be prospected to locate the one desired. The difficulties of transporting provisions and machinery were very great, as Cana is situated on one of the spurs of the Andes, at more than 2,000 feet above sea-level, with higher mountains, and a very broken country intercepting the way to the navigable portion of the Tuira river, which forms the natural outlet to the Pacific. A 10-stamp mill was erected in 1889. For many months the results were far from encouraging. The ore from what is known as the North mine proved of poor quality. No signs of the wonderful riches were yet in sight. The working capital was being rapidly exhausted, and doubts were beginning to enter the minds of the organizers of the company, when a happy incident caused a favourable turn in affairs.

PART OF THE TRAMWAY BETWEEN MINES AND MILL.
Showing Cana plateau, and Paca range in the background.

In January, 1893, the prospecting shaft at the South mine struck old workings at ninety feet below the surface, and the water that had accumulated in them rushed in and flooded the mine. Were these the old workings of the Espíritu Santo mine? To answer the question, new capital was subscribed, and the mine was drained by the construction of a drainage adit, consisting of a tunnel 1,100 feet long, opening on the hillside. This tunnel was finished in August, 1894. After the water drained out, extensive old workings were revealed. Some of the galleries had fallen in, and the extraction of any kind of rock was dangerous; so they had to proceed slowly and cautiously. To expedite the work, it was necessary to sink the Heenan engine shaft a short distance from the lode. At one hundred feet below the adit a cross-cut was commenced towards the ore-body, which was struck in December, 1895. A few days later the workmen again found empty cavities. The Spaniards had evidently been farther down than had been supposed. Old implements and tools slowly came to light, —iron bars with steel points, hammers, remains of leather buckets, pieces of manila rope, wooden bateas about eighteen inches in diameter (probably used to carry the ore out of the mine), and six tread wheels (evidently worked by slaves for raising the water). Some of the wheels and many tiers of timbers were found in place and in good condition, after nearly two centuries of burial.



HEENAN ENGINE SHAFT, ESPIRITU SANTO MINE.

All the above findings agreed so closely with the description of the workings of the Espíritu Santo mine, given in the Spanish records, that no doubt was now left as to its identity, and the efforts were directed to get below the Spanish workings. The engine shaft was continued to one hundred and eighty feet below the adit, making a total depth from the surface of three hundred and thirty feet. The cross cut was driven from this point, and reached the lode during the summer of 1897. This level seems to be below the Spanish workings; at least, no evidence has been found to the contrary. While the engine shaft was being sunk and the cross-cuts were being driven, mining was going on among the old workings, which have yielded during the last two years 10,528 ounces of gold, realizing in London £44,522.* The average value of the rock treated has varied from 1 to 1½ ounces of gold per ton. As all the mining so far has been confined to the portions that had been left thoroughly honeycombed by the Spaniards, who had undoubtedly removed the richest portions, a much larger yield is expected from the virgin lode which is beginning to be worked at the lowest level. The results so far achieved point to the full realization of expectations.

The lode formation of the Cana mines differs considerably from the ordinary ore deposit, and for that reason it is interesting from a geological point of view. The gold is associated with fragments, mostly of calcite, that fill the cavities in a volcanic rock,—andesite. These cavities do not seem to have measured more than a few inches in any dimension. The gold is mostly found around the outer portion of the material filling the cavity, and in contact with the enclosing andesite. The lode, at a depth of one hundred feet below the adit, or two hundred and fifty feet from the top of the engine shaft, is 80 feet wide and 120 feet long. At a point 80 feet lower it is 90 feet wide; sufficient work has not been done to determine its length.

The water is taken out of the mines by means of two Rittinger telescopic plunger pumps, placed at the present lowest level, one hundred and eighty feet below the adit and worked by two hydraulic motors, at the adit level, with which they are connected by steel rods. The two motors can be worked independently or together; likewise the two pumps. Their combined maximum capacity is 600 gallons per minute for a lift of 700 feet. The motors work under a head of 330 feet of water, which is conveyed from the Seteganti river by a ditch four feet wide and three deep, and six miles long, cut on the side of a steep hill. Many crossings of small ravines and creeks required the construction of 1,200 feet of flumes, built of 1½-inch planks and resting on trestles some of which are 15 feet in height. The grade of the ditch is fifteen feet to the mile. Its total cost, in-

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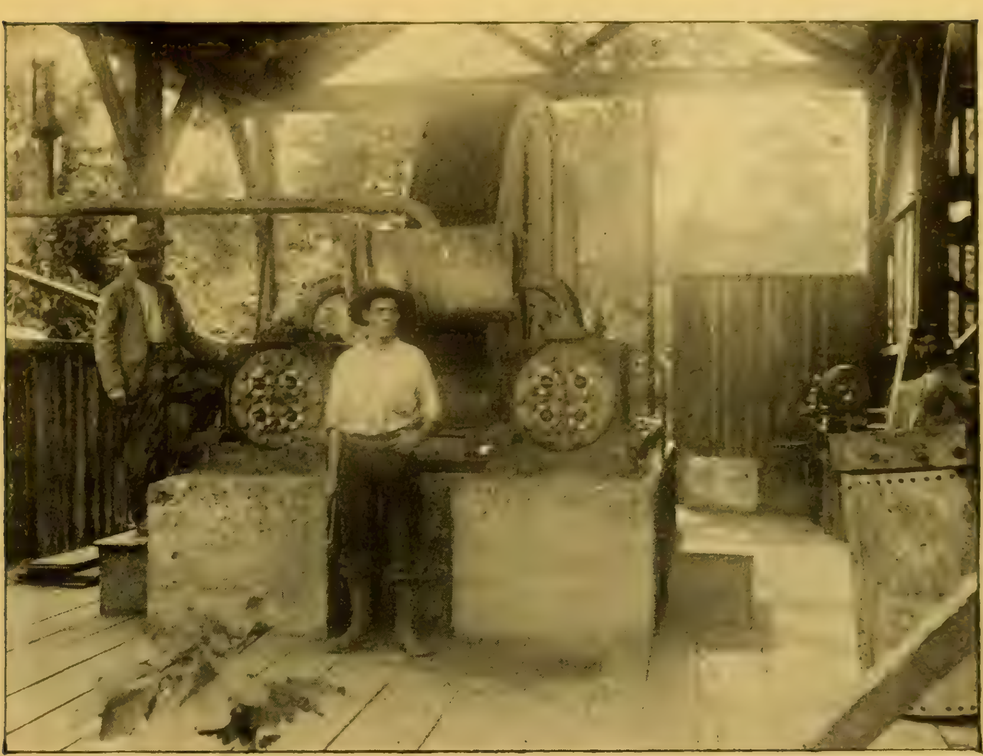
* From the last annual report of Mr. E. R. Woakes, who has been manager of the Darien Gold-Mining Company for the last six years, and to whose energy and ability a large share of the success of the enterprise is due.

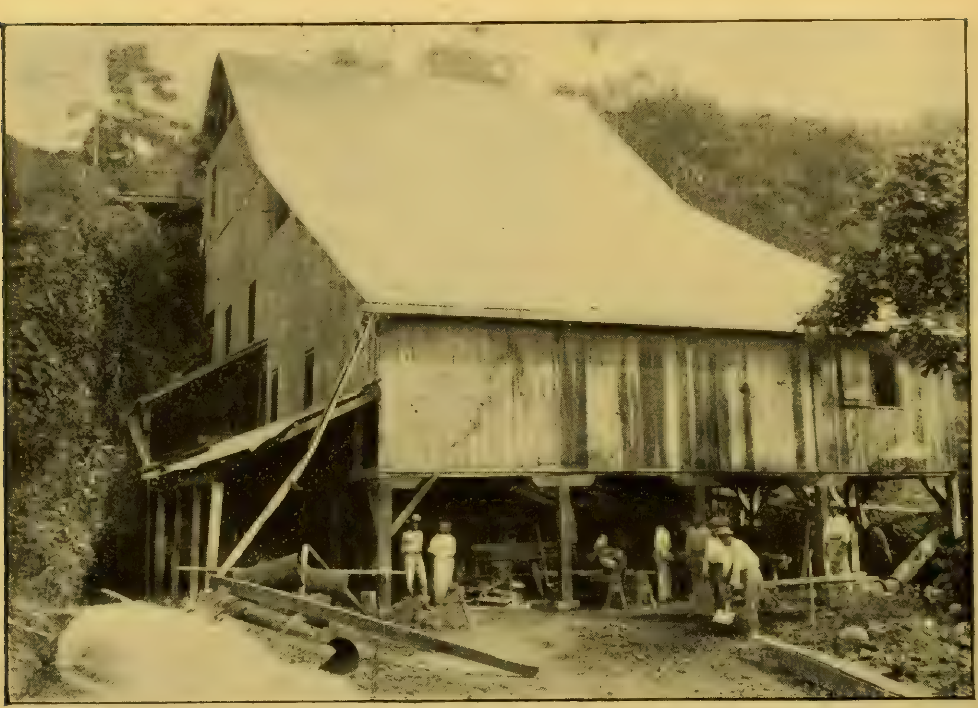


PELTON WATER WHEEL, DIRECT-CONNECTED TO AIR COMPRESSOR.

cluding flumes, flood gates, and overflows, was $24,000 in Colombian currency,—equal to about $11,000 in gold. The work was completed in fifteen months. The water is led by a steel-riveted pipe from the end of the ditch to the hydraulic motor.

Compressed air is used in the mines for hoisting, drilling, and operating a Cameron sinking pump. It is generated by a Schram duplex air-compressor, driven by a 14-foot steel water-wheel, constructed on the Pelton principle by Heenan and Froude, of Manchester, England. An unusual feature of this wheel is that it is mounted direct on the crank shaft of the compressor. It works under a head of 90 feet of water, which is brought from the Cana river by a ditch nearly three-quarters of a mile in length. Adjoining the compressor house is the machine shop, which is operated by a small Pelton motor wheel. A dynamo connected direct to this motor furnishes light for the shop, the compressor house, and underground.

The ore from the engine shaft of the Espíritu Santo mine is taken to the mill on cars hauled by mules over a tramway half a mile long. These cars are emptied into ore bins having a total capacity of one hundred tons, whence the ore is delivered by four automatic feeders to the same number of Fraser and Chalmers batteries of five stamps, weighing 850 pounds each. The ore is chiefly free milling, about seventy per cent. being extracted by amalgamation. The sulphurets



THE STAMP MILL.

are kept for future treatment. Recent experiments, carried out in Cana by a cyanide expert, Mr. G. R. Carey, show that the tailings are very amenable to treatment by that process, and a cyanide plant is now being erected. When completed, it is expected that the rate of extraction will be raised from seventy to nearly ninety per cent.

The stamp mill is operated by a six-foot Pelton water-wheel under a head of 96 feet, which is soon to be raised to 200 feet. The present ditch takes the water from the Cana river, and is half a mile long. The higher-level ditch will take the water from the same source, but will be two miles long. A continuous current dynamo, driven by a special Pelton motor, supplies electric light for the mill and principal buildings.

The company has erected a saw mill two miles from Cana. The power to run a 52-inch Hoe saw is furnished by a Leffel turbine under a head of 20 feet of water. This is conveyed from the Escucho Ruido river by five hundred feet of ditching. The timber is felled in the adjacent woods, and hauled out by oxen.

The installations awaken a feeling of admiration for the patience and perseverance of those entrusted with the work. Lack of a good road has been a serious drawback to the proper development of the mines; but, as soon as the workings in the Cana mine had proved the value of the property, it was decided to improve the unsatisfactory system of transportation that had so far prevailed. To carry out that purpose, I was requested by the Darien Gold-Mining Company to proceed to Darien to report on the feasibility of building a railway, or a macadamized road if a railway proved beyond the means and requirements of the company. With that end in view I arrived in Panama towards the latter part of December, 1896, and at sunset one evening, shortly afterwards, I put out for Darien. At dawn of the next morning our sloop was sailing on the calm waters of the Pacific and passing close to the Pearl islands, so called on account of the large number of pearls covering the surrounding sea-bottom. The shells are secured by divers, who make a specialty of the work. Although the majority do not contain pearls, they are all valuable as mother-of-pearl. At the end of the second day we were entering the extensive gulf of San Miguel where the Tuira river empties into the Pacific and about one hundred miles south-east of Panama. While sailing on the majestic Tuira, at the mouth of which there are no bars to obstruct navigation, we were able to make headway only at six-hour intervals,—that is, while the tide was running in. The rest of the time it was necessary to anchor, to prevent the sloop from drifting back with the strong current caused by the outgoing tide. The swiftness of the current in either direction—due to the tide, whose effects are felt in a diminishing ratio for sixty miles up the river—will be easily understood when it is known that the difference between high and low tide in the gulf

OFFICE OF DARIEN GOLD-MINING CO., REAL DE SANTA MARIA.

of San Miguel is twenty-four feet. Being forced to these frequent stops, two of which were made in front of native villages, our progress was naturally slow. We passed swarms of alligators, some of them from fifteen to twenty feet long. On the fifth day from Panama we reached Real de Santa María, the end of navigation, more than fifty miles from the mouth of the river. Near Real de Santa María there can be seen the ruin of the old town built by the Spaniards in the sixteenth century, with the forts they used to defend it from the repeated attacks of the Indians and pirates.

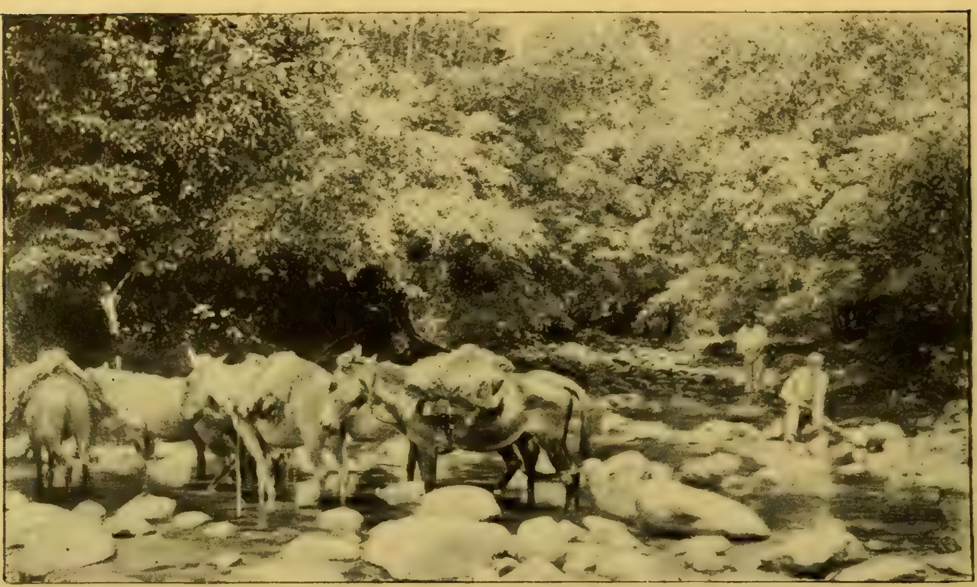
On the morning after our arrival we started on the inland journey, and, after nearly nine hours of hard muleback riding, over marshes and rugged hills and among colossal trees, we reached Cituro, the half-way station, where the night was spent. To this point the Cupe river, one of the affluents of the Tuira, is navigable by canoes during the rainy season, when most of the cargo is floated up. The loaded canoes sometimes make the trip in four days, but often require more than double that time. In the dry season scarcity of water in the Cupe river, makes navigation more difficult, and the canoes have to stop three miles below Cituro. In the rainy season the return trip from Cituro to Real is oftener made by canoe than overland. The thrilling experience of shooting down a few rapids below Cituro, and the changing tropical scenes at every turn of the winding river, add novelty to this manner of making the return-journey, which takes from twelve to fifteen hours. The road from Cituro towards Cana

FERRYING ACROSS THE CUPE RIVER.
The tenth crossing, by the old road.

STARTING ON A CANOE JOURNEY.

crosses the Cupe river nine times, and runs up the Cupe hill, which rises abruptly about five hundred feet above its foot. Thence up and down a series of smaller hills to the crossings of the Paca river; thence up the steep Paca hill, towering nearly a thousand feet above its base. After reaching the summit, a rapid descent of four hundred and fifty feet took us to the upper Tuira, so close to its source that the river, at the crossing, is very shallow and hardly fifty feet wide. A ride through the Cana plateau, a picturesque and fertile valley a few miles in extent, and a further rise of two hundred and fifty feet along the Espíritu Santo range, brought us to the end of the road at the Cana mines. All the ascents and descents over the Cupe and Paca hills were made on very steep and long grades, varying from 20 to 27 feet in 100 feet! It is not surprising, therefore, that the cost of transportation over these twenty miles has been more than $50 in Colombian currency—equal to about $23 in gold—per ton. The cargoes are mostly carried on the backs of mules or oxen, which take at least two days to make the journey during the rainy season. Wagons can be used only during two or three months in the dry season, when it requires the combined force of six mules and four oxen to haul one of them, with a load of only fifteen hundred pounds, over the mountainous portion of the road, at the slow rate of ten miles a day.

After a thorough investigation of the whole question, I reported against the construction of a railway or tramway for the present, as



PACK MULES CROSSING THE RIVER PIEDRAS.

the limited traffic would not warrant the expense, but advised the construction of a macadam road along a route which I selected, the covering of broken stone or gravel to be made six inches thick and about eight feet wide. Such a road, the construction of which is now well advanced, will make possible the use of wagons at all seasons of the year, and cause a great yearly saving to the company. While it can be built at a comparatively small cost, it will satisfy all the demands of the region for many years to come.

The difficulties of exploring were greatly magnified by the dense-

BRIDGE ON THE TRAMWAY LINE BETWEEN MINES AND MILL.

ness of the forest. We had not gone very far from Cana with our reconnaissance when we discovered that the Paca river and the upper Tuira run much nearer to each other than any one had supposed them to. As the distance between them grows less, so does the height of the portions of the Paca range separating the two rivers. This depression is so marked that we were able to cross the divide at a point five hundred feet lower than the old road. Had we begun the gradual descent to the Paca river, flowing four hundred feet below, as soon as we reached the summit of the new Paca Pass, we would have had to cross many gorges, or deep ravines, requiring the construction of high and long bridges; but, by locating the road along the hillside and keeping it at a uniform elevation for more than a mile, we obviated the necessity of these expensive structures, as the gorges were crossed so near their sources that they became mere ditches with small openings to bridge. The descent was made gradually, without crossing any of the deep ravines that run up into the mountain side. After reaching the narrow valley formed by the Paca river, we followed it till we came to the Paca cañon. At this place the river narrows considerably, and runs between two nearly vertical walls, rising several hundred feet in height. The hillside is so steep that, while trying to force a passage through the best portions, we had to walk in single file, treading carefully after each other, and in each other's foot-

TRANSPORTING SECTIONS OF STEEL PIPE TO THE MINES.

prints, always holding fast to some near-by branches or roots to prevent an occasional slip from sending us to the bottom of the precipice. After carefully looking over the surrounding country, we discovered that at a point about one hundred feet above the river there was a break in the steepness of the slope, and through this section it was comparatively easy to locate the road. To overcome this height the line was raised gradually along the hillside from a point some distance back, and, after crossing the cañon, it was lowered in a similar manner. The maximum grade used in the new road is ten per cent., and this only at short and rare intervals. The greater portion of the road is on much easier grades, and presents a pleasing contrast with the long grades, having a rise of 20 or 25 feet in 100, in the old road. The great expense and delays resulting from the sixteen crossings of the Cupe river by the old road from Cana have been done away with.

THE STEAMER DARIEN.

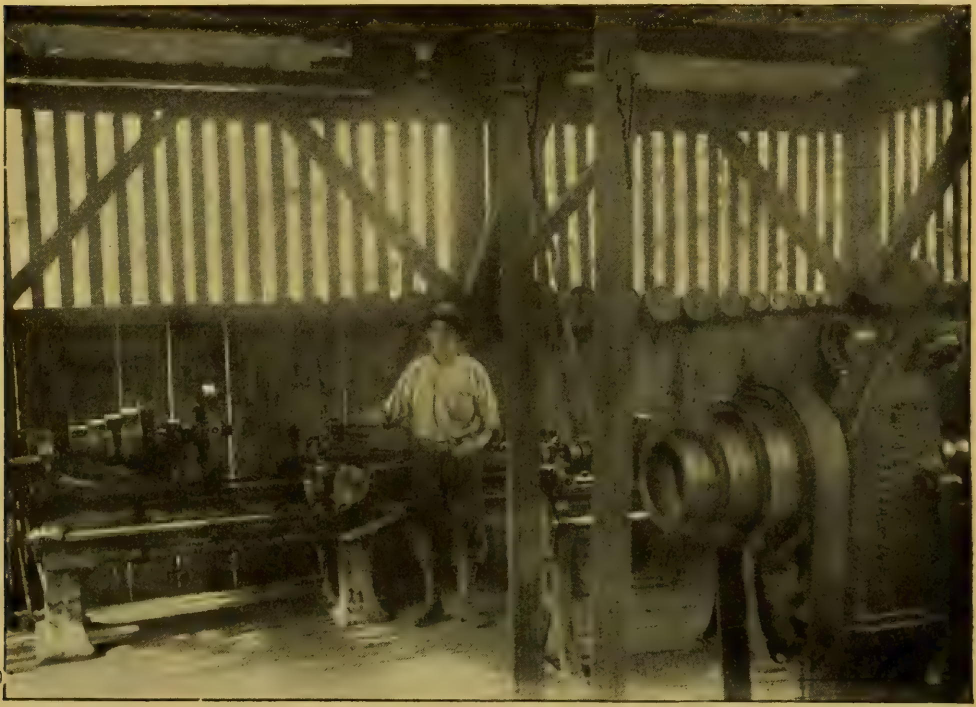
The improvements in transportation facilities have not been confined to overland. The little steamer Darien, with an elegantly-fitted cabin and capacity for twenty tons of freight, was sent out from England, and since March has been making trips between Panama and Real de Santa María in twenty hours. The sloops previously used took from four to twelve days.

While camping on the mountains, notwithstanding the fact that we were only eight degrees north of the equator, we found it necessary to use very heavy blankets at night, during the dry season from

ENGINEERS' CAMP ON THE PACA RANGE, 2200 FT. ALTITUDE.

IMPROVISING WATER-PROOFS FOR THE RAINY SEASON FROM NATIVE RUBBER.

January to April. The only disagreeable features of the region in that otherwise pleasant portion of the year are the unbearable *garrapatas*[*] and the no less detestable *coloradillas.* Those minute insects infest the forests, and somehow or other find their way through the clothing to inflict a punishment much more severe than would be expected from their insignificant appearance. Their reign, however, is of short duration, as, after the first few showers of the rainy season, they completely disappear. Among other unpleasant visitors in those forests we found the big fly which produces the "*gusano de monte.*"[†] This fly injects into the skin the germs of a tiny worm, which bores into the flesh. If not removed before it has gone very far, it will produce serious complications. To the inexperienced the sore looks like a common abscess; but the natives recognize the true cause at a glance. After the application of moist tobacco for about half an hour, a slight pressure will bring out the worm. Without the use of that narcotic, however, no amount of pressure will make it loosen its tight grip. Black ants, growing to about an inch in length, are also common, and sting like a scorpion.



IN THE MACHINE SHOP.

The wealth of Darien is not limited to gold. It is very rich in valuable timber, and a considerable amount of mahogany has been

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[*] *Racinus hexapoda.*
[†] *Hypodermo boris.*

THE IVORY-NUT PALM.

exported. The palm producing vegetable ivory is very abundant. The rubber industry was also very profitable, at one time, but the natives' inexcusable practice of cutting down the trees, instead of simply tapping them to take out the rubber, has greatly diminished the output. In spite of this wholesale destruction, however, a day hardly passed while we were surveying through the forest that we did not see rubber trees. They thrive so well in that locality that their planting and cultivation ought to prove a remunerative investment. When the rainy season was approaching, we extracted rubber from some trees near one of our camps, and, by the use of a simple process adopted by the natives, we rendered water-proof all the ordinary cloth-bags that we had been using for carrying our clothing and instruments from camp to camp. We used them during the rainy season to our complete satisfaction. A coat treated in the same manner proved more impervious to water than the imported ones.

THE WORKING OF RAILWAYS IN MILITARY OPERATIONS.

By W. L. Derr.

"Go forth, my son, and see with how little wisdom the world is governed." —*Chancellor Oxenstein to a young diplomat.*

IF recent events prove anything, it is that the great chancellor's words are strongly applicable to the present practice in military transportation.

It is strange, indeed, that the art of transportation has apparently been given the least attention by military authorities. In many instances the transportation of a large army has been left in the care of men almost wholly without knowledge of their duties. Stranger still is the fact that so little attention is paid to this important branch in the training of soldiers. Glance over the curriculum of any great national military school, and you will be surprised at the comparatively small amount of time devoted to the study of transportation,—and how little of that which is taught is of a really practical nature. As showing in a degree at least, how the practical side of the study of transportation as applied to railways is passed over in military schools, the writer recalls an accident on a railway near one of these schools. The road in question was blocked for a number of days by a landslide, and, though he was frequently on the ground inspecting the progress of the work, he did not once see any of the cadets there, nor could he find that any of them had visited the scene. Yet the work of restoring the line involved some of the most original and interesting methods of handling earth and of tunnelling known to modern practice,—just the kind of knowledge that should be acquired by an engineer, civil or military,—a knowledge applicable to many other undertakings than the opening of a railway line.

The transportation business, like any other profession or trade, must be studied carefully through a long apprenticeship, and he who engages in directing transportation without having served such apprenticeship is bound to bring disaster to the enterprise. The fact that men almost wholly without practical knowledge of railroading are sometimes placed in charge of a railway in times of peace is no reason why such men should be placed in control of a military line. In ordinary civil affairs about the worst a man can do is to lose money for his employers. In military affairs too much is at stake to warrant any experimenting. The building and operation of military roads should at all times be placed in the hands of men thoroughly trained in such work. The mere fact that a man has been, say, a successful grocer, and has, in the course of his business, received a few hundred car-loads of goods by rail, is no argument whatever that he would make a successful railroad man, any more than that it is evidence that he would make a successful general in the field.

Undoubtedly railroads will always play a very important part in war operations, whether offensive or defensive. By their aid the long delays formerly incident to the bringing together of opposing armies will be obviated. These armies will arrive quickly and about the same time at the objective point,—that is, the frontier. The objective railroad points are naturally the large railroad centers, junctions, etc.; these will be strongly fortified, and will, no doubt, be points toward which attacks will be directed, because there, especially if in the rear of the army, will be placed the army supplies, etc.

The carrying of an army's supplies in the form of provisions is in itself a problem of great magnitude. When it is considered that at the best a region, no matter how fertile, cannot be counted upon as furnishing more than a few days, supplies for an army, it will at once be apparent that some means must be had for transporting additional supplies, and this means is generally a railroad. In a country where the railroads are built for purely commercial purposes, of course the best will have to be made of the situation as it exists; but, where railroads are built for strategical reasons, naturally their general direction will be toward the frontiers and to fortified places, and other important points, such as those where magazines and general supply and rendezvous stations are to be located, all of which points have, of course, been previously selected by the military staff.

Regarding the construction of a railway only the most general principles can be laid down. Local requirements and conditions must always prevail. The principles of construction—proper drainage, protection of the roadbed from the effects of running water, use of the best and heaviest material in the roadway, etc.—are so well known as to require no explanation. Heavy curvature or grades within reasonable limits should not be feared. It is much easier to use helping engines to overcome heavy grades than to materially reduce the grade in the construction of the line. Bridges should be of a strength a little in excess of actual requirements,—a fact to be borne in mind in designing the floor system and lateral bracing.

It is in the early stages of a war that great railway movements are made,—during the mobilization of an army and the forwarding of its equipment and supplies; and right here should be laid down a principle not to be deviated from—that all other than military business must be suspended over a line of railroad conveying troops and their stores to a point where there is probability of an early attack. In other words, commercial interests must not in any circumstances be allowed to interfere with military movements of an important nature. Preferably the detailed movements of trains should be directed by the local civil organization of the railroads. There may be conditions under which it would be advisable to give certain operating officials military rank of a grade sufficient to ensure respect for their authority. But the instructions to such operating officials must be emphatic as to the priority of military over commercial movements. It is fair to assume that modern armies will—or certainly should—contain a sufficient number of technically-trained railroad men to at once take hold of, and operate if necessary, such of the enemy's railroad lines as may fall into their hands, and to do other work incident to the operation of railroads which it may not be advisable to entrust to civilians.

As train movements in America are almost universally directed by telegraphic communications, it is highly essential that the telegraph lines be carefully guarded and kept in a high state of efficiency. Moreover, the telegraph lines used in the handling of trains must not be burdened with other business, if the trains are not to be delayed waiting for their orders. Military men must bear in mind that frequently trains from one direction must meet trains in the other direction, superior trains must be run around inferior ones, and a thousand and one other details relative to the movements must be sent to the conductors and engineers in charge of such trains; and that therefore certain telegraphic facilities must be reserved at all ordinary times for the exclusive use of the train-dispatcher.

The organization, for operating purposes, of an American railway is by divisions, the ranking officer of a division being the superintendent, who is assisted by a trainmaster, a roadmaster or division engineer, a master mechanic, and a chief dispatcher, each of these assistants being at the head of a separate bureau. Speaking generally, the officers perform these duties: the superintendent is in charge of the division; the trainmaster ranks next below the superintendent, reporting to and in his absence acting for him, and has supervision over the trains and trainmen, and, in case of a wreck, over the wrecking; the master mechanic has charge of the shops, machinery, engine fuel, and mechanical stores, and general charge of enginemen and firemen when they are at headquarters. He is often assisted by a road foreman of engines, or traveling engineer, who rides upon engines and instructs the enginemen and firemen in the performance of their mechanical duties. The road master, or division engineer, has charge of the roadway, including the track, bridges, and buildings. He is often assisted by an engineering force, a master carpenter, master mason, and track supervisors, the latter having charge of the track on a sub-division of the line. The chief dispatcher has charge of the train dispatchers, telegraph operators, signalmen, telegraph-line repairers, and signal inspectors, and of the distribution of power and cars. The train dispatchers, only one of whom is on duty at a time for a specified territory, issue orders in the name of the superintendent, for the movement of trains by telegraph. Dispatchers are on duty continuously—that is, one dispatcher does not go off duty until relieved by another, to whom the relieved dispatcher delivers a written summary of all train orders outstanding, as well as of other information necessary for his guidance. On some roads this arrangement of the duties of operating officers differs in the details, but in the main it is that found on the average American railway, and is the one best adapted for military lines, as responsibility is easily placed and difficulty arising from parity of grade is avoided.

The comparative slowness in the movements made by railroads in transporting armies and army supplies has often been caused by inadequate terminals, passing sidings, and signaling. It may be laid down as an axiom that the capacity of a railroad is the capacity of its terminals. In other words, trains cannot be run faster or more frequently than they can be made up and gotten out of terminal yards. Accordingly, if it takes, say, thirty minutes to switch a train and put it in shape for a return trip, that is the average headway on which trains can be run. In order, then, to get the very best results in train service, so far as concerns the rapid movement of troops, the movement must be practically continuous.

Generally the first move to increase the capacity of a railroad is to double, and even quadruple, the main tracks, without much regard to the expansion of terminal facilities. But, without a corresponding increase of the latter, there is practically no gain, no matter how much the main track facilities are increased. Even on European lines built wholly for strategical reasons this principle has been grossly violated. Yards are often arranged in such a manner that incoming trains must be held back while preceding ones are being switched. Of course, sites for the detraining of an army cannot always be selected beforehand. But it is fair to presume that railroads built primarily for military purposes will terminate at points where, under ordinary conditions, such detraining will take place. With proper block signal and braking appliances for controlling the movements of trains, the trains can be run with safety at two- or three-minute intervals, even at comparatively high speed. But, by the ordinary methods of the arrangements and working in yards, it will take at least ten times that long to get a train ready for a return trip, or out of the way of a following train. With the ordinary yard-handling of, say, an army corps, it is only a question of a very short time when the yard will be filled to overflowing, which means that trains *en route*, when this occurs, must be held back until the blockade is raised.

The remedy for this is an arrangement of tracks that will permit of a continuous movement without breaking the train, except for the purpose of setting off, when necessary, a disabled car or engine, or to hold such cars as it may not be possible to unload at the moment. The circular or curved track, forming a continuous "head on" connection between the ingoing and outgoing main tracks, seems to be the only arrangement of track by which this situation can be brought about. With it a train, as soon as unloaded, is ready to proceed on its return journey.

In the operation of a military terminal the "interlocking machine" will be found almost indispensable, because this makes it possible to concentrate in the hands of one man the throwing of switches of a particular district, thereby obviating any loss of time from trouble arising through misunderstanding when more persons than one perform this duty. Of so much importance are these machines that every precaution should be taken to ensure the protection of the buildings containing the mechanism, even going so far as to armor them where they are exposed to fire. The simplest and easiest part of the movement of trains is their advancement when once clear of the terminal, just as a ship's greatest difficulty is to get out of the harbor or enter it. Once clear of land, the ship's movement is largely a matter of mathematics, until land is again sighted; so with a train: once out of a yard, it is easily handled, until it arrives at another yard. Open spaces for the debarkation are necessary for prompt movements,—a fact which was clearly demonstrated at the World's Fair at Chicago in 1893. There the Illinois Central Railroad conveyed 509,000 people in one day. In many instances these trains were unloaded before they were fairly stopped. But the passengers in this case were people of both sexes and of all ages, and much care had to be exercised in order to prevent personal injuries. With soldiers, the trains could have been unloaded without coming to a standstill.

The care and the distribution of power call for the most constant attention. In addition to the power actually used on the trains, engines should be stationed at points a few miles apart, so as to be available in case of the breaking down of an engine hauling a train.

The wrecking outfit should be immediately available, day and night, during heavy and important movements. In wrecking operations, the point to be aimed at is clearing of the track, regardless of damage to rolling-stock; no attempt should be made to pick up the damaged cars during the continuance of the heavy movement. It is perhaps needless to add that damaged cars loaded with ammunition and other explosives must be handled with much care, and, when off the track, unloaded under the care of an expert, if one is available, before being moved. Wreckage must not be thrown on such cars, as a spark might be generated or other action caused that might set off the explosives.

The ordinary passenger car, with only end doors, is not so well adapted to the prompt loading and unloading of passengers as is a car with side doors. With cars having end doors, in loading and unloading passengers,—especially unloading,—each car should be made to take care of its own lading,—that is, the passengers should not have to pass from the platform of one car to that of another. Freight cars equipped with air brakes and Master Car Builders' standard couplers can readily be converted into passenger cars, as was done practically by the Pennsylvania and Illinois Central railroads during the World's Fair. The former company used the type known as gondolas, the side stakes being carried high enough to support the sides and roof.

The sides of the car were left on and the remainder of the side built upon them, the gondola ends being removed and ordinary box-car body ends, with doors, substituted. The Illinois Central equipment was of the standard box-car type, with side exits, similar to the open cars of street lines, the seats extending across the car. The sides of the car were carried to the roof at the ends of the seats. Where low station platforms are used, a step running the entire length of a car with side exits is of advantage. With the Illinois Central equipment, it was found that a train could be loaded or unloaded in a minute, and in many instances in less time when the station platforms were of the same height as the floor of the cars. It will be recalled that this traffic included many women and children,—passengers who had to be handled with greater care than it is necessary to exercise in transporting troops.

For the loading and transportation of heavy and unwieldy material, the rules laid down by the Master Car Builders' Association (see M. C. B. report for 1897) should be followed. Cars for this purpose should be carefully inspected before being loaded, and only those in the best condition should be used. In general, it may be said that lading bearing on more cars than one should be so placed that the weight will be distributed over the trucks as evenly as possible. The lading should have bearing near its ends only, so that the cars will "curve" freely, and, when loaded in cars with sides, it should be kept at least twelve inches from the sides by a single bearing on each side of the load at each end, placed opposite the bottom bearings. Very heavy guns require cars of special construction. A car that was used recently for carrying a 137,000-pound cable for the Metropolitan Traction Company, of New York, which car was built by the Wabash Railroad, has four trucks of the ordinary diamond truck pattern, each pair of trucks being connected by equalizing bars, so as to form one truck, the sills and all other parts being very heavy. Through the spool upon which the cable was wound, there passed a heavy stick of timber, each end of which rested on heavy timber bents placed over the centers of the trucks. Such a car would carry heavy guns.

The handling and storing of explosive compounds is a matter which calls for much consideration. Mr. Henry S. Drinker, E. M., in his work on "Explosives, Machine Rock Drills, and Blasting," on page 93 says: "In warm latitudes, cool storing places are necessary, while in cool countries it is advisable to select only such places as will ensure a temperature of from 50° to 60° F. (10° to 15½° C.) being maintained. Cellars or sheds covered with earth prove the best in all climates. Particular cautions with regard to storage of gunpowder are hardly necessary; its characteristics, liability to ignition and consequent explosion, being familiar to all. With glycerine compounds, however, the fact is indubitably established that, when in good condition, they are absolutely non-explosive under ordinary circumstances, unless fired by percussion and heat combined, or under pressure. These compounds are only rendered liable to explosion by the presence of the caps or exploders; therefore too much care cannot be used in the storage of the two."

Such shipments should be packed in strong cases, preferably of a size and weight that one person can handle, and each package should be marked "Explosive" on top, sides, and ends. Nitroglycerine should be packed in an absorbent of some kind, to prevent leakage. Any package showing signs of leakage should not be loaded. The packages must be loaded bottom side down,—this on the supposition that the cartridges are so packed that they lie on their sides, not on their ends, when the packages are so loaded. The packages must be so placed in the car that they cannot in any circumstances fall. Percussion caps, exploders, fulminators, matches, and like articles, must, in no circumstances, be loaded in cars with explosives. Only cars in first-class condition should be loaded with explosives. They must be tight, with no openings through which sparks can enter. All cars that contain explosives should be labeled to this effect, on the outside, and also bear the admonition to handle carefully. Instructions for the handling of explosives, in the event of transfers having to be made, will no doubt be issued by the military staff, and should be placed in the hands of the railroad staff, including wreckmasters.

In loading heavy material the railroad-wrecking plant, especially the heavier types of steam derricks, will be found of great value. Many of these machines have a capacity of from twenty-five to fifty tons, and may be used in handling almost any class of military equipment, including the heavier guns. Field pieces will be loaded on flat cars and on gondola cars with low sides. If the latter are used, the ends should be removed, even though they are of the drop end pattern. The removed ends should accompany the cars to destination. In loading field guns, wagons, and wheeled vehicles in general, it has been found well to place a string of cars at the loading place and start the loading from one end, a portable incline being used to raise the guns, etc., to the floor of the car. Better still, at permanent depots, is a ramp or incline of earth at the loading end of the track and built on the extension of the line of the track. A team of horses, walking on the ground alongside the cars to be loaded, tows the guns, with towline attached to their sides, to the farthest end of the string of cars. " Gang planks " of hard wood or of metal are used to bridge the openings between the cars. Before loading, all the cars should be coupled, and, in addition, when necessary, chained together, with the brakes set up. In all cases, a rigid inspection of the cars should be made before they are placed for loading, special attention being given to the trucks, brake rigging, couplers, and sills.

A few words as to the destruction of railroads. It is certainly to be hoped that destruction of transportation lines will not be resorted to except in the most extreme cases. A railroad may be rendered inoperative, without doing much damage to it. By the removal of a few of the important members of the track, telegraph line, locomotives, and cars, the whole line may be rendered useless. There is nothing to be gained by the destruction of station buildings and shops. These play so little part in the immediate operation of a line as to make their destruction of no use.

The railroad employees, especially despatchers, signalmen, and trainmen, are recommended to keep a cool head when handling military business. If under fire, their chances of escape are much better if they keep their wits. Further, upon their coolness may depend great things. Dispatchers, particularly, must not get "rattled," if things near the front get a little "thick." Much may be going on there that cannot be grasped from the reports, which at the best are but general in character. It is usually safe to assume that the other man is doing pretty nearly the right thing,—that at least he is carrying out the general rules laid down for the handling of trains. Power and equipment should be kept well in hand, and the wrecking force where it is promptly available.

GREAT RAILWAY STATIONS OF ENGLAND.

By Thomas Cargill.

SO soon as the Great Central Railway, together with its diminutive brother, the Central London, and a few other minor relations, are opened for traffic, there will be, in round numbers, four hundred railway stations within the metropolitan radius of twelve miles. But a few can advance any claim to be included in the title of the present article. There is, therefore, no necessity for entering into superfluous details respecting the exact number of stations each main line can boast of, but it may be interesting to state the order of precedence among the principal railways having termini in the English capital. First and foremost there is the Great Eastern, next the London, Brighton & South Coast; then the South Eastern, to some extent its rival, followed by the South Western. The London, Chatham & Dover occupies the fifth place, pressed hard by the Great Northern, after which come the Metropolitan and the District, which might, in mathematical language, be bracketed. It is a little curious that the great London & North Western should be the ninth in the scale, and may be regarded as the last, since the remaining examples call for no particular mention. On the supposition that each of these four hundred London stations accommodated only the up-and-down traffic of a double-track of one railway company, they would still present enormous facilities for the transit and transport of passengers and goods. It will be readily recognised how greatly these facilities are accentuated, when it is known that as many as three and four companies use the majority of these stations. For instance, the terminal station of the London, Chatham & Dover railway at Victoria serves, in addition to its own line, the Midland, South Western, and Great Northern lines, which all run into it. Again, the Addison Road station, which is the joint property of the London & North Western and Great Western, accommodates both the South Western and the London, Brighton & South Coast railways. If therefore so many of the four hundred stations as are used by more than one company were credited with each separate service, or, in other words, multiplied by the number of the individual companies running their trains into them, they would reach a total of nearly seven hundred, instead of four hundred.

It has been more than once remarked by outsiders that one railway station very much resembles another; the statement perhaps is true of roadside stations. It must, however, be a very inobservant traveller indeed, assuming that he were acquainted with the Euston terminus of the London & North Western, and with that of the Midland at St. Pancras, who could fail to perceive the widely-different distinguishing characteristics of the two stations.

All railway stations may be classed under one of three heads,—terminal, intermediate (or, preferably, through), and a combination of the two. It will be seen subsequently that this triple classification is susceptible of further subdivision, and that some stations which are generally regarded as belonging to the first type are not strictly faithful examples of it. As an instance, take the St. Pancras station, already quoted, which is unquestionably a terminal station for the lines connected with the Midland railway system. But it is not so for others. The city trains make a through station of it, and it is to provide separate tracks for these that the extensive widening of the Midland line at Kentish Town is at present in progress and nearing completion. In the third class may be included many junction stations, which, while acting as through stations for the main up-and-down traffic, are termini for the branch, or branches, running into them. When these latter are of short length, and consist of a single track, they are generally worked on the see-saw, or shuttle, principle. The Charing Cross and Cannon Street stations on the South Eastern railway, and that of the London, Chatham & Dover at Victoria, are, among others that could be mentioned, perfect examples of terminal, or dead-end, stations. The general arrangements of an ordinary double-track through station is represented in Fig. 1, in which the letters CP, SC, and CS indicate a cattle platform, signal cabins or boxes, and a goods shed, the rest of the diagram being self-explanatory. Communication between the two platforms is effected by means of a foot-bridge. Dotted lines show the centre lines of the road approaches, the principal thoroughfare crossing the line at AB, either on the level, or in the form of an over-bridge, or as a subway. For many years the first of these methods has been practically tabooed by the British public and the board of trade. In the country, where the necessary land can be readily and economically acquired for forming the approaches for an over-bridge, the erection of it constitutes the safest, most convenient, and, in the long run, cheapest of all means. Subways are absolutely inevitable in large towns, especially in connecting a high-level station with a low-level station. Perhaps the best-known example in London is the subway between the Metropolitan and the London, Chatham & Dover. It is a simple matter to keep these subways, which are so short, and, in addition, well lighted and constantly full of passengers, in proper order and under constant supervision. But the case assumes a very different aspect when the tunnel is a quarter of a mile long or more, and the shades of night close in. Wretchedly lighted as they all are, they are a continual source of trouble and annoyance to the police, who are charged with the maintenance of them and the protection of those passing through them. So strongly do the Parisian police object to the building of *sousterrains*, on the score of decency and morality, that on the metropolitan and suburban lines which are intended to serve the great exhibition of 1900 the use of them has been vetoed, and foot-bridges are to be adopted instead.

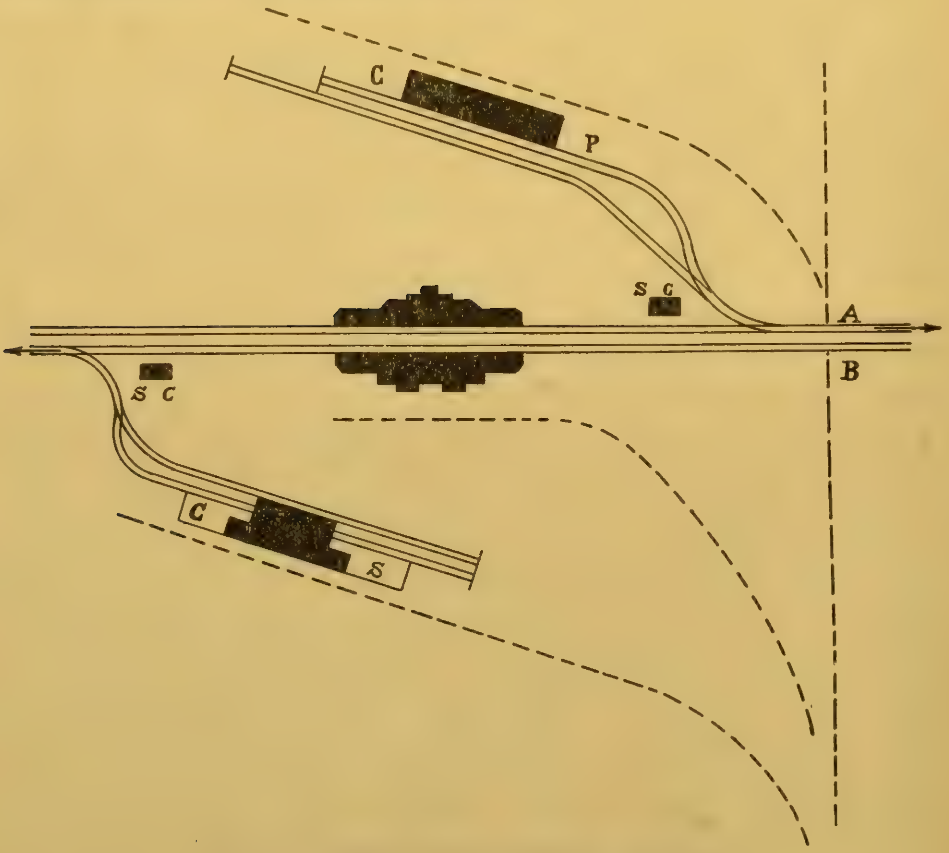


FIG. I. DOUBLE-TRACK THROUGH STATION.

When a through station of the kind represented in Fig. 1 becomes a junction station, it follows, after the main lines of traffic clear the signal cabins, that several lines radiate from them in the direction of the different branches, thus giving rise to the French term of *gares de bifurcation*. There is one more instance which may be adduced, before passing on to terminal stations; it is shown in the diagram in Fig. 2, which is sufficient to elucidate the principle. A passenger travelling in the direction from A to B is desirous of reaching C. After traversing the proper distance in the direction of B, past the points at P, the train proceeds in the direction of C,—that is, toward the traveller's goal. In a word, the train retraces to some extent its original course, and causes the passenger to do so also. Hence the French term for these stations, *gares de retroussement,* of which there are some very good examples at Marseilles, Amiens, Lille, and Orleans. If Waterloo terminus be supposed to be situated at A, Waterloo Junction being shown in black and lettered W. J., then the terminus at Charing Cross will be represented by C. Although a continuous single track is shown from A to B, and is laid, it is used only on special occasions. The passengers walk from the Waterloo terminus under cover to the Junction,—a very short distance,—and then entrain either for Charing Cross or the city.

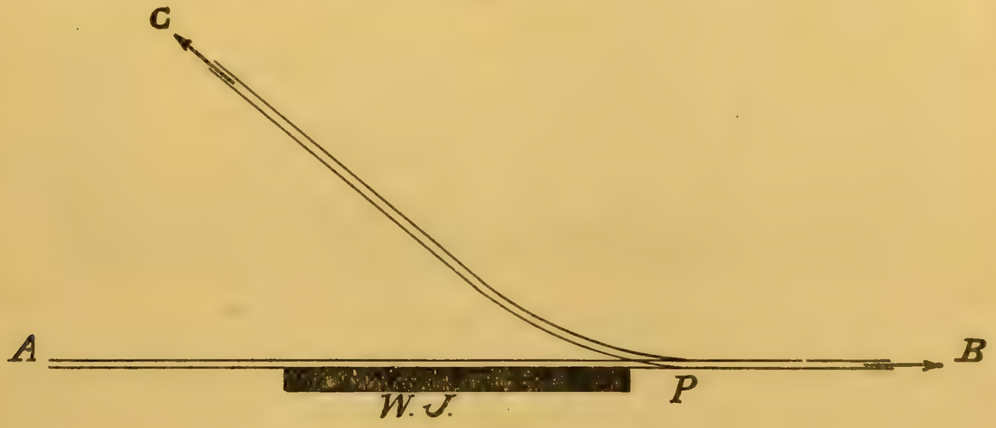


FIG. 2.

There are three ruling principles dictating the lines to be followed in the setting-out of railway termini. The first of these systems, more particularly observable in the older examples, is that in which the booking-offices, the waiting-rooms, and the other permanent station-buildings are arranged alongside or parallel to the departure platform. Under the second category may be classed all those stations which have these structures disposed at the dead end, and at right angles to the terminal tracks. A combination of the first two systems forms the third. A very good instance of the last-mentioned is the terminus of the London, Chatham & Dover railway at Victoria, in which the buildings and offices serving the main line are located in accordance with the principles of the first system, while those belonging to the local and suburban traffic follow the method adopted in the second. In future these three systems will be designated the parallel, the end, and the compound. The second of these can be employed in through stations. Such buildings must be placed either over or under the tracks. At Vauxhall, the ticket station for the Waterloo terminus of the London & South Western railway, the offices, with the exception of a couple of waiting-rooms, are all below the platforms, thus obliging passengers to ascend and descend a long and sufficiently steep flight of steps,—although there is a lift for luggage. Again, at some of the large stations on the Metropolitan District railway the buildings are placed squarely over the permanent way, and the platforms are completely clear and unencumbered, save for a bookstall or two, and perhaps the slender columns carrying the roof. In both cases, the inevitable ascent and descent are present, and the transport of luggage is a troublesome and tedious affair. The large station at South Kensington is a good example of this class of structure. A sketch plan of a terminal station on the compound system is given in Fig. 3. It contains an extra platform, A, which allows trains carrying luggage from the continent and foreign countries to come alongside. Platforms similar to A in the figure, are frequently termed dock platforms, and invariably have a dead end.

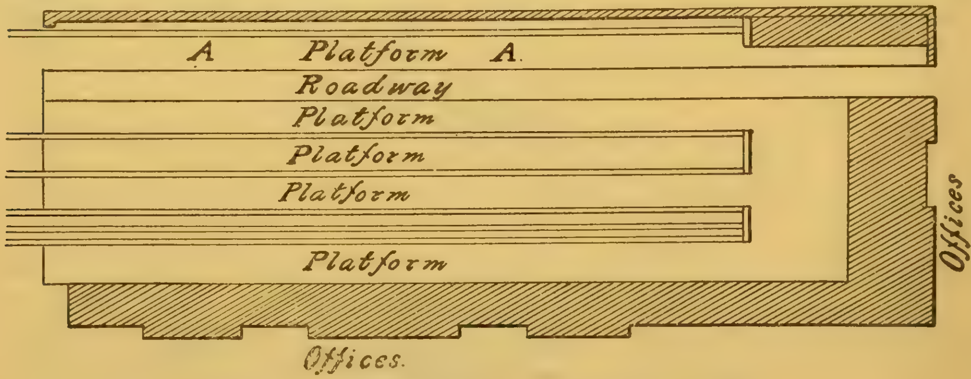


FIG. 3. TERMINAL STATION, COMPOUND SYSTEM.

Before passing to the description of the great stations of any particular main line of railway, there is one more general example which should be noticed,—island stations, or island platforms. These possess many advantages as through stations, especially when they act also as junctions for one or more branch lines. In this instance the offices, refreshment-rooms, and other conveniences are placed upon one broad platform extending across from one main line to another, and, if there are any branch lines, they run alongside a dock platform forming parts of the main one, as shown to the right of Fig. 4. Occasionally the booking-offices are placed on an island platform, but more generally either above or below it. If the station be on an embankment, the access to the platform from the booking-office would be

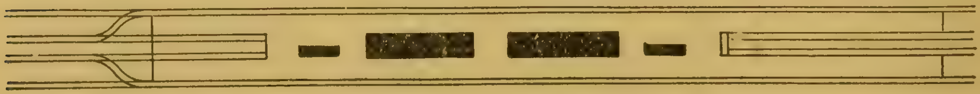


FIG. 4. ISLAND STATION.

a subway, and, if in cutting, by an over-bridge, which might be restricted to pedestrian travel or not, according to circumstances. The allegation that foot bridges are exceedingly unpleasant and inconvenient to passengers is true, but it is not invariably the case that they form great obstacles to the moving of personal luggage. All platforms, or very nearly all, terminate by a short ramp, and the porters run their barrows up and down them and across the tracks without troubling themselves with either subway or bridge. There can be no question respecting the facilities which the island-station principle affords for traffic, and, since all the platforms, or, rather, parts of the same platform, are on the same level, the transference of passengers and their belongings from one train to another is accomplished with ease and rapidity. Besides, one range of station buildings suffices for the travellers by all the trains, and the working staff can be employed at a minimum of labor and expense. It may be mentioned that all the through stations on the Great Central railway from Annesley, ten miles north of Nottingham, to London,—a total distance of nearly a hundred miles,—are designed and laid out as island-platform stations. When running over the northern half of this new route to the metropolis, in June last, I was much struck with the excellent manner in which the service of the public and the railway company was provided for by the employment of these island stations.

TABLE.

Name of railway	Length of system in miles.
The Great Western	1,900
The London & North Western	1,700
The North Eastern	1,560
The Midland	1,310
The North British	1,080
The Great Eastern	1,020
The London & South Western	800
The Caledonian	710
The Great Northern	670
The Lancashire & Yorkshire	520
The London, Brighton & South Coast	420
The South Eastern	360
The London, Chatham & Dover	180

One of the largest and most important of the great railway stations in the British metropolis is that of the Great Western at Paddington. Like some of its contemporaries, "antiquity's pride it has on its side," and, although shorn forever of its splendid, but fatal, distinguishing characteristic,—the broad gauge,—it can still boast of the longest mileage of any railway in the kingdom. It also has the longest stretch of line, the distance from Paddington to Penzance amounting to 324 miles, though this is closely approached by the London & North Western, with its 318 miles, from Euston to Carlisle, and also by the Highland service from Perth to Wick, a journey of 306 miles.

It is rarely that the absolutely necessary, or even a marginal, amount of land can be exactly obtained for the site of a terminal or a through station in London or in the large provincial towns; the consequence is that frequently a surplus area of ground has to be acquired, or what at the time was regarded as superabundant. This land in many cases has been sold, on the supposition that it would never be required, and yet but a few years afterwards it, together with the buildings upon it, has been repurchased at almost exorbitant prices. Assuming that a sufficient area has been obtained for an important terminal station, the configuration of it is a most important point. For, it must be borne in mind, the ground plan,—and here the engineer comes to the fore,—both in shape and size, must be utilised to the maximum, for the laying of the tracks, the arrangements of the platforms, and the general construction of the station, irrespective of all esthetical or other considerations.

A plan of the terminal station of the Great Western Railway at Paddington is represented in Fig. 5, from which it is evident that it is laid out on the first, or parallel, principle, as all the offices and buildings are located on one side of the station. It has a very expansive open space at the dead end, marked AA in the plan, measuring nearly two hundred feet from the buffer-stops of the tracks to the rear of the Great Western Royal Hotel. There are, in all, seven platforms, but, while four of these are single,—each serving only one track,—*viz.*, 1, 8, 9 and 10,—the other three are double, and serve two, one on each side, the tracks being designated in the stations as 2-3, 4-5, and 6-7, respectively. The Great Western terminus lies very snugly between two stations of the Metropolitan railway,—the one at Praed street and the other at Bishop's road,—and is connected with both by suitable subways and inclines. Four of the platforms, commencing with No. 1, are used as departure platforms, and the remainder as arrival platforms, although occasionally one or other of the latter fulfils double duty. Having booked himself to his destination at the ticket-office on platform No. 1, and supposing his train to depart from No. 2, 3, or 4, there are three routes open to the passenger by which he may get alongside, without incurring the penalty for "crossing the line." He may go *viâ* the foot-bridge marked FB in the annexed plan, or he may pass on to any of the platforms by walking along open space at the dead end, which communicates with

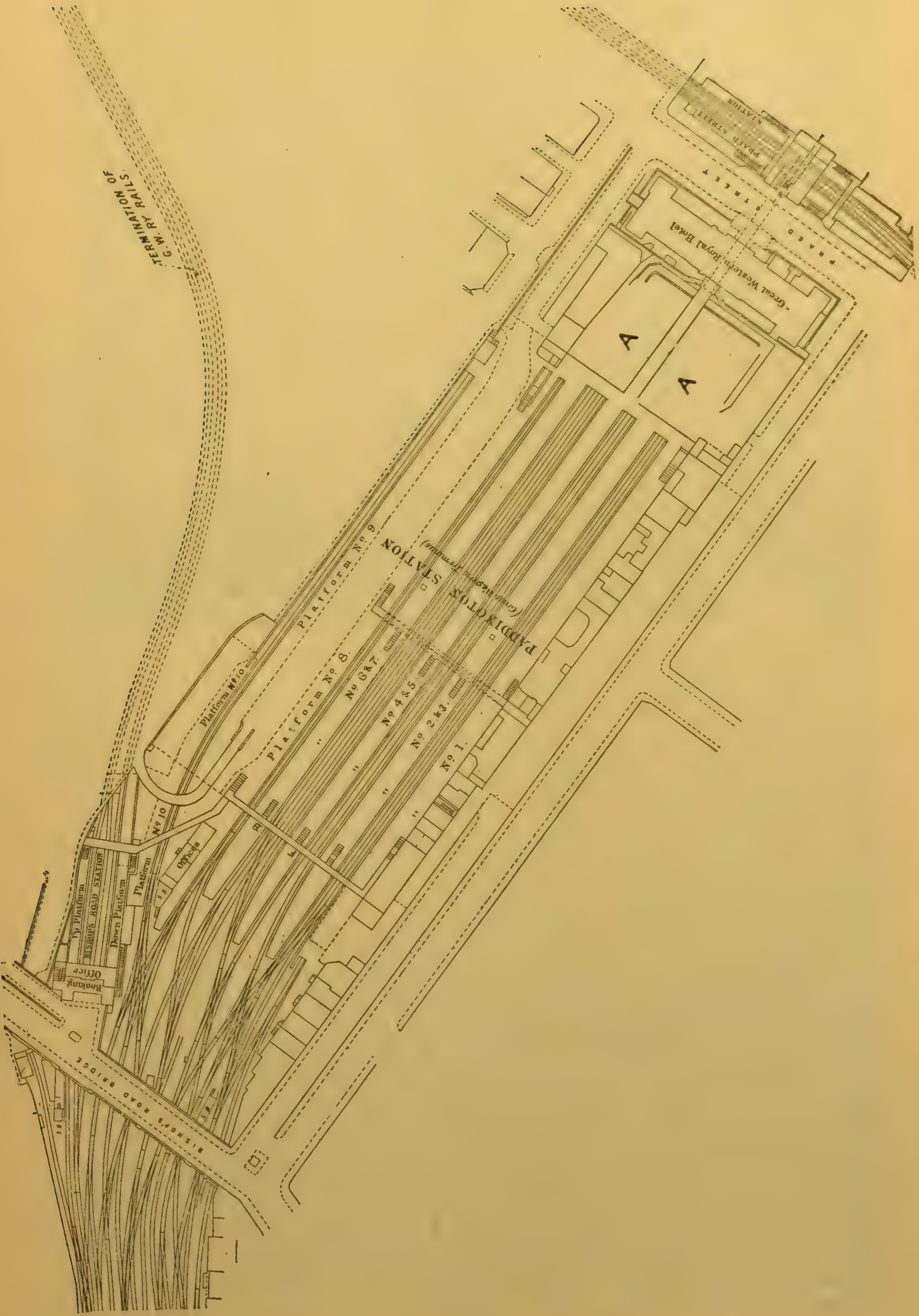


FIG. 5. PADDINGTON STATION, GREAT WESTERN RAILWAY, LONDON.

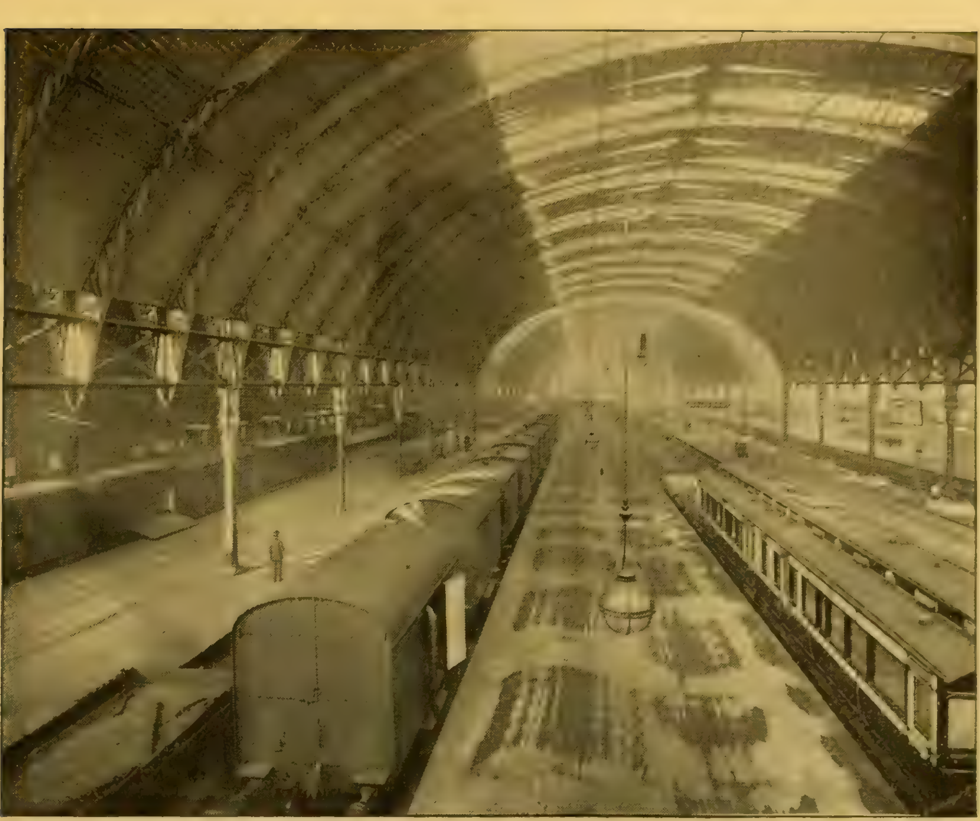
them all, in some cases through gateways. There is a third method of access, but it is available between platforms 1 and 2 only. It consists of a traveller, or portable platform, which, when not in use, lies concealed underneath the first platform. When in action, it is hoisted out, run across, and raised to the proper level, forming a level gangway, or small bridge, for the transit of passengers and goods from one platform to the other.

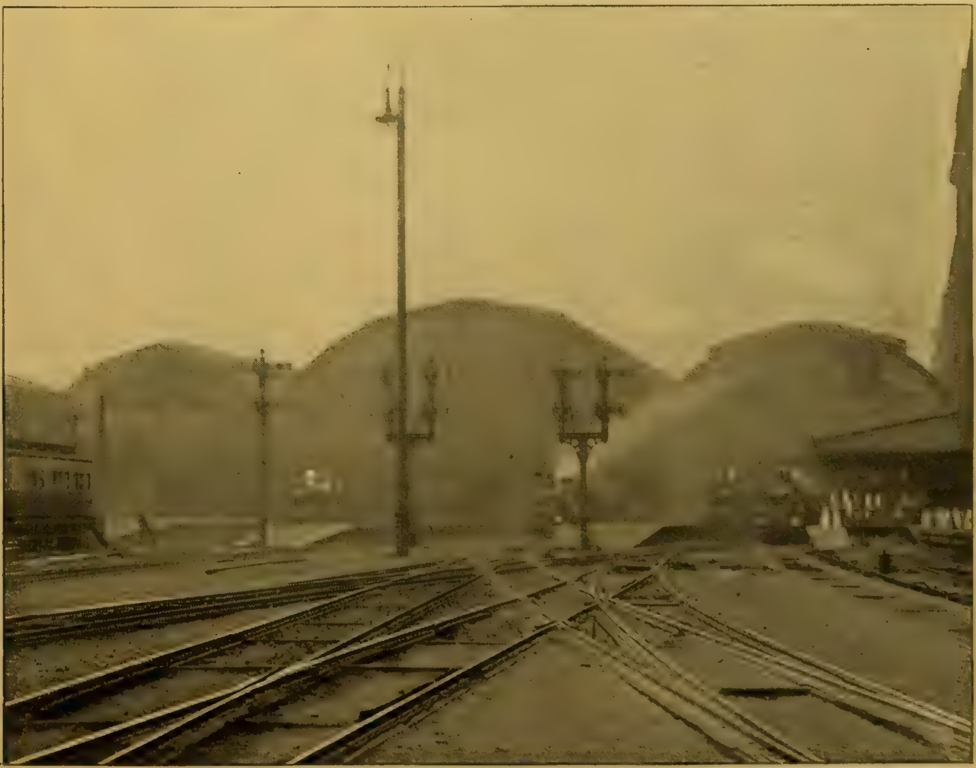
Between platforms 8 and 9 there is the usual roadway where carriages and cabs can pull up to receive passengers and luggage. The total length of the principal platforms is some 850 feet.

The parallel principle has one advantage, or, at least, what many people regard as such, although I think the point a doubtful one ; at least one or two of the departure platforms are without barriers. This allows the friends of passengers to "see them off." An excellent proof of the confusion and delay caused by the practice is afforded by the scene at the departure of one of the Portsmouth, or other long-journey, trains, from the main line platform of Waterloo Station.

The covering, or the roofing in, of a large terminal station is one of the gravest problems that the engineer has to solve. The site of nearly every large station, whether terminal or through, presents physical features peculiar to itself, which call for especial treatment. The design and construction of the roofs of large stations is simply a question of columns or no columns. Is the roof to be in one span from side wall to side wall, or is the total breadth of the site to be subdivided into two or more separate openings? The real solution of this difficult question depends mainly upon two points,—the form and dimensions of the site, and the money available.

The Great Western terminus was commenced in 1849 and finished six years subsequently. The whole roof consists of three spans, and is carried partly on columns, and partly on the side wall of the offices and other buildings flanking the first platform. There are, therefore, a central span of 102 feet and two side spans, 68 feet each. The total length of the roof is 700 feet, and the breadth is 283 feet. The introduction of two transepts, each fifty feet wide with iron girders resembling groined arches, is the especial feature which distinguishes this station roof from all others in London. In general appearance the roof is very light ; it is constructed of wrought-iron arched ribs, every fourth rib being rigidly connected to the cast-iron supporting columns. The two intermediate ribs in every bay are secured to open web girders running from column to column, the entire length of the roof. All the columns are bolted down to large masses of concrete, to give them sufficient lateral rigidity. The area of a station depends not so much on the absolute size of the roof spans as on





FIGS. 6 & 7. INTERIOR AND WEST FRONT OF PADDINGTON STATION, GREAT WESTERN RAILWAY, LONDON.

the total width, from side to side; and this dimension, in the example before us, is 283 feet, or just 43 feet more than the width of the St. Pancras station of the Midland railway. It is no wonder, therefore, that, in spite of the increase of traffic, the Paddington terminus is as nearly adequate to meet it, as are other examples built more recently and of far larger proportions. For instance, the Liverpool Street station of the Great Eastern line has a total width of 504 feet. The spans of the Great Western roof are very well chosen for an important terminal station, as they allow a very suitable and convenient subdivision of the available space. No more columns are introduced than are necessary, to avoid the use of large trusses, which are expensive, and, if heavy, detract seriously from the light and elegant appearance which should characterise structures of this sort. An elevation of the west front of the station is shown in the photograph in Fig. 7, with the ends glazed in. It is a little curious that, when the "Royal," originally The Great Western, Hotel was built, no tenant could be found for it. Some of the directors, unwilling that so fine a property should remain unproductive, constituted themselves a small company to lease and carry it on,—an undertaking which has met with all the success it deserves.

King's Cross station, the terminus of the Great Northern railway, like the station at Paddington, is laid out on the compound system, but the arrangement of the tracks is different. It is worthy of note that this is one of the few large stations in London or elsewhere which can be entered from the street-level without the necessity of surmounting inclines, or ramps, or climbing flights of stairs. There are five platforms, and between Nos. 1 and 2 there are no less than six tracks, with turntables for four of them. It is very seldom now that turntables are used for carriages, but they were very serviceable when the coaches were of the old short four-wheel pattern. The great length of the more modern carriages prohibits the use of any turntable, unless it be one some fifty-five feet in diameter, and large enough to take a full-sized engine and tender. Forty-six feet in length is a very ordinary dimension for bogie coaches. The cars for the Waterloo & City railway, just opened for traffic, are fifty feet long, and one of the Queen's saloons is more than fifty-six. It will be seen from the plan that, by means of its suburban station for local lines, which is altogether distinct from that portion of the terminus appropriated to the traffic of the main line, the Great Northern is in communication with the Metropolitan railway on one side, as it is on the other by a connection at York Road station. There is one feature pertaining to nearly all terminal stations,—the spreading out, or fantailing, of what might be termed the normal number of tracks, into many times their original total. In the example under notice, for

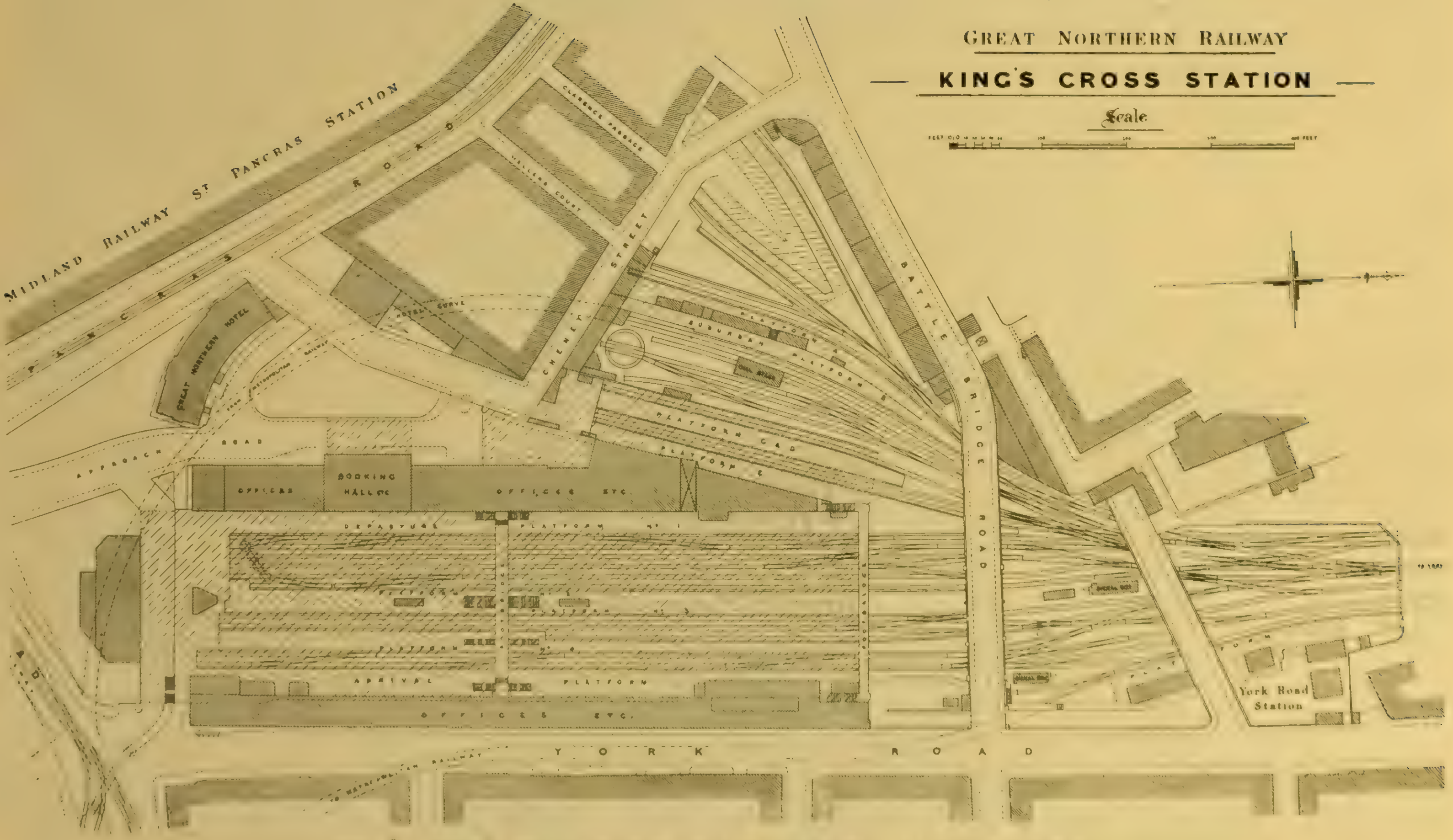


FIG. 8. KING'S CROSS STATION, GREAT NORTHERN RAILWAY, LONDON.

instance, there are six normal tracks, which may be classified as two for the local or suburban traffic, two for that of the main line, and two for that of the goods. At the far, or dead, end of both stations, these six tracks spread out into no less than nineteen. At the Great Eastern terminus at Liverpool Street, the same number of normal tracks multiply into twenty-four.

From wall to wall the King's Cross station roof measures two hundred and twenty feet, and the whole breadth is divided into two spans, each of 105 feet. This measurement is exclusive of the smaller covered-in spaces and side entrances and approaches. The original roof of this terminus consisted of a pair of semi-circular timber arches of 105 feet span, constructed on the laminated principle introduced many years ago by a French engineer named de l'Orme,—a method now obsolete. These laminated arched ribs were spaced twenty feet apart, and were built up of several layers of boards one and a half inches in thickness and screwed together. The boards were of various lengths, so as to break joints. The present arched ribs, erected some four years ago, are of iron, and rest upon the same side walls and pillars, as shown in the photograph in Fig. 9, which represents a part of the departure platform near the dead end and looking down the line towards the foot bridge. In Fig. 10 is given another view of the station in the reverse direction. There is a detail in the construction of the roofs of large railway stations which has not received the attention it

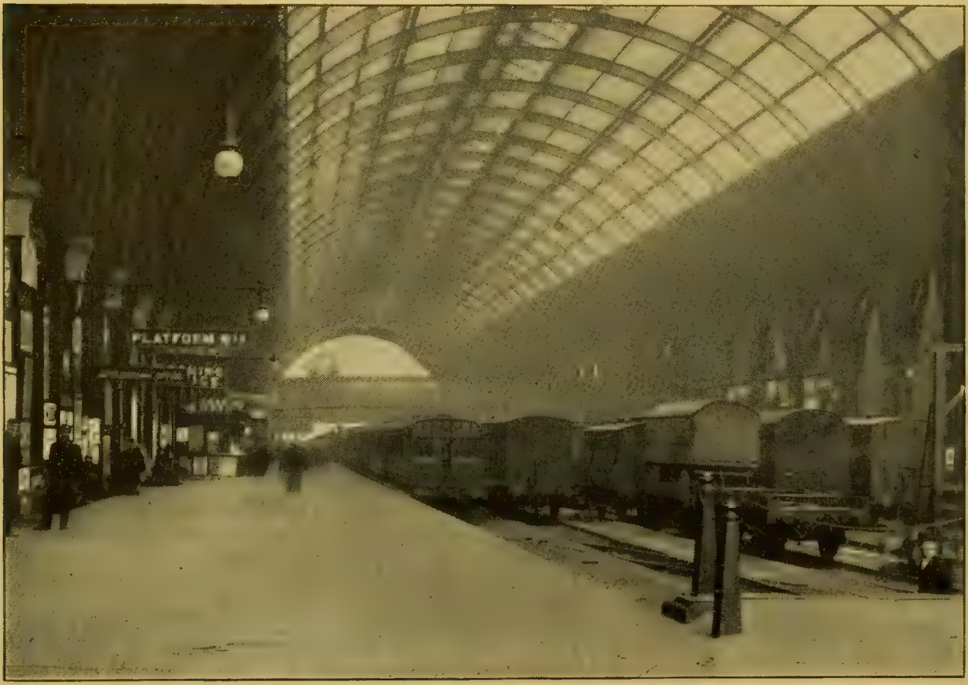


FIG. 9. MAIN DEPARTURE PLATFORM, KING'S CROSS STATION.

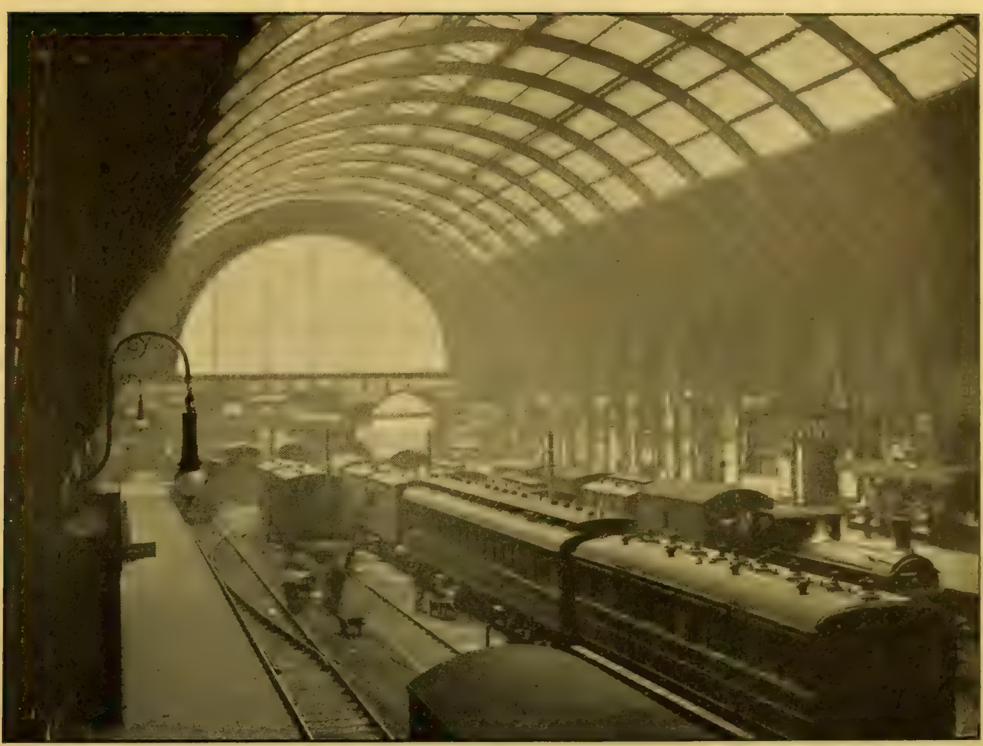


FIG. 10. DEPARTURE SIDE, KING'S CROSS TERMINUS, LONDON.

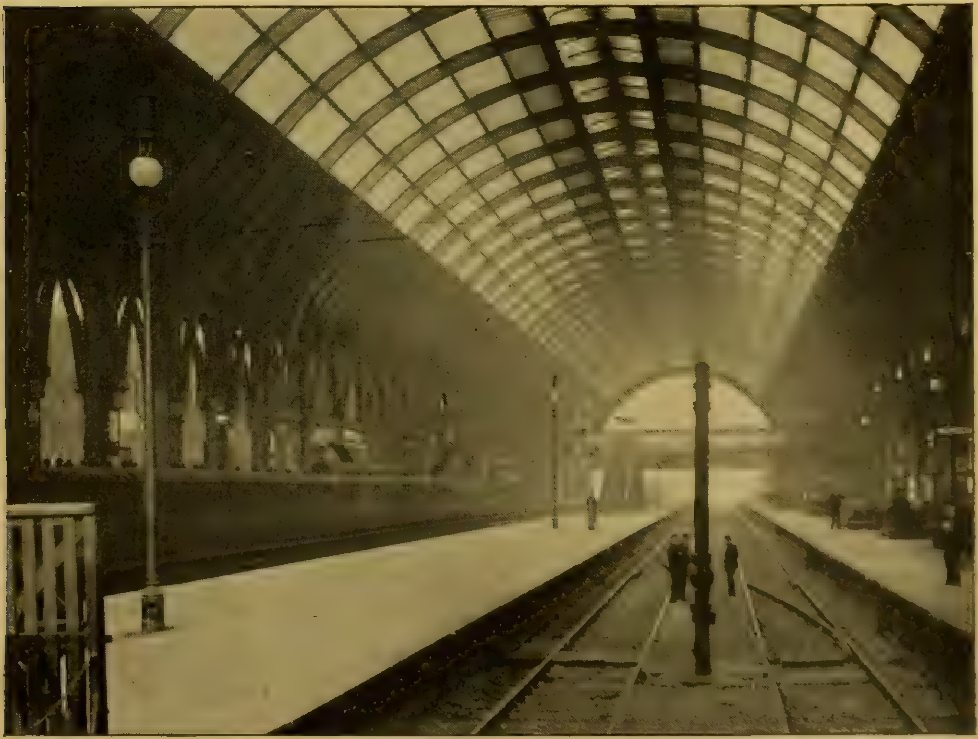


FIG. 11. ARRIVAL PLATFORM, KING'S CROSS TERMINUS. GREAT NORTHERN RAILWAY.

deserves. It relates to the subdivision of the total area of the roof into parts that admit light and those that do not. In a word, the diurnal lighting of a terminus is not by any means so much a matter of mere routine as it is usually considered. There are three methods generally employed for this purpose. The first is to place the skylights at and near the crown, or apex, of the roof, according to the design—arch or truss. The second is to distribute the glazed part along the sides. The third is to alternate the glazed and the opaque portions from the crown to the springings. It must be borne in mind that the object is not the concentration of natural light on any particular part of the station, but its uniform diffusion to every part of it, so far as circumstances will permit. I should class these three arrangements as central, side, and alternate lighting. The two examples already selected belong to the first, or central, lighting method, and a glance at the photographs will show that the platforms and tracks in the vicinity of the side walls, and lying under the shadow of the unglazed parts of the roof, do not receive their fair share of light. Part of the arrival platform at King's Cross is shown in Fig. 11, and access to the separate platforms is had either by means of the footbridge, or, more conveniently, by passing round at the dead end of the terminus. An elevation of the end of the station looking on the Euston Road is given in Fig. 12; notwithstanding its

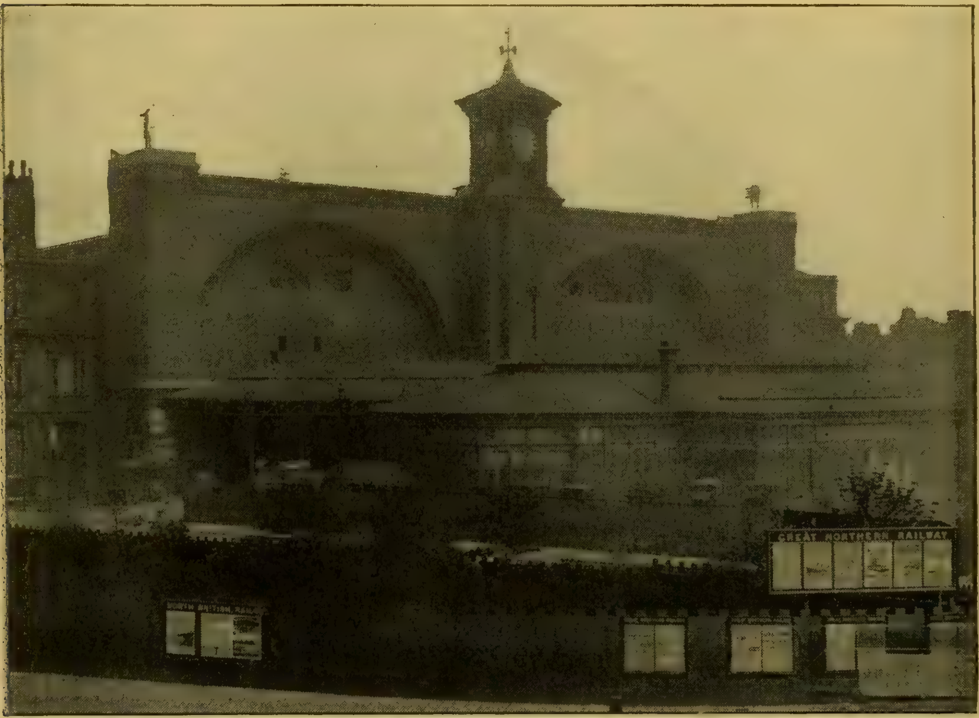


FIG. 12. KING'S CROSS TERMINUS, GREAT NORTHERN RAILWAY, LONDON.

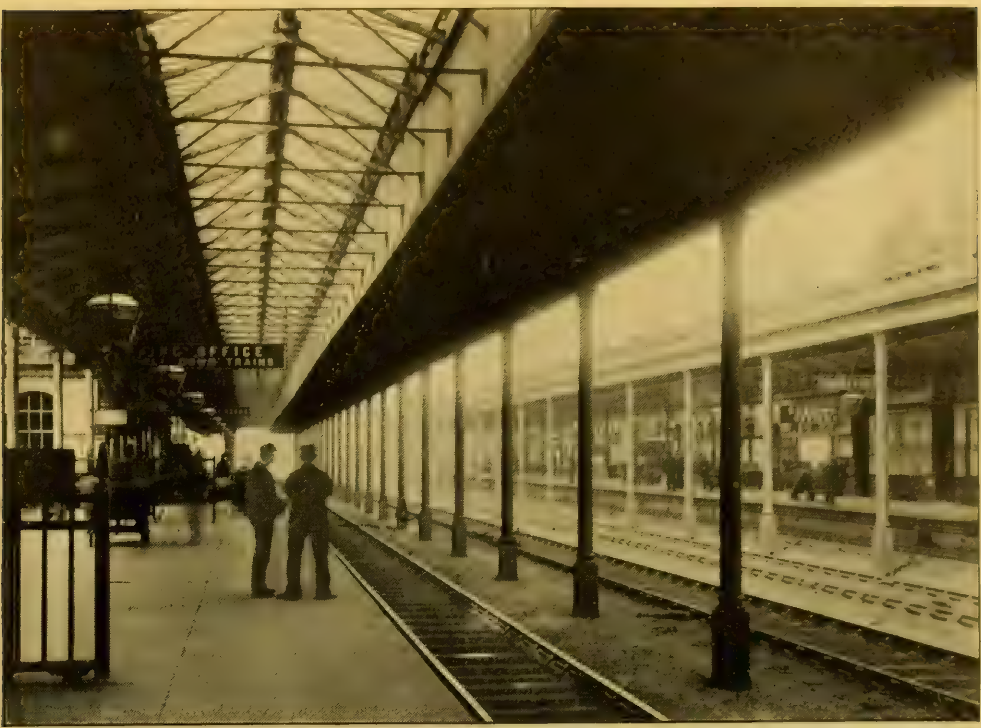


FIG. 13. DONCASTER STATION, GREAT NORTHERN RAILWAY. LOOKING NORTH.

imposing appearance, it is completely dwarfed by its gigantic neighbour, the Midland railway station and hotel.

The town of Doncaster, which can be reached by both the Midland and the Great Eastern lines, is an important station on the Great Northern system, as lines from Manchester, Leeds, and Grimsby run

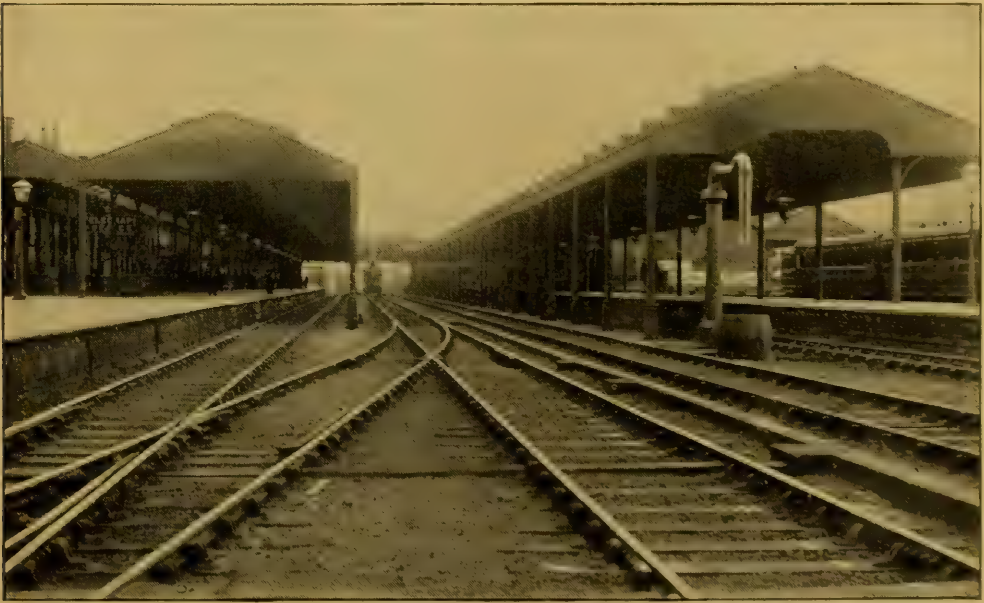


FIG. 14. DONCASTER STATION, GREAT NORTHERN RAILWAY. LOOKING SOUTH.

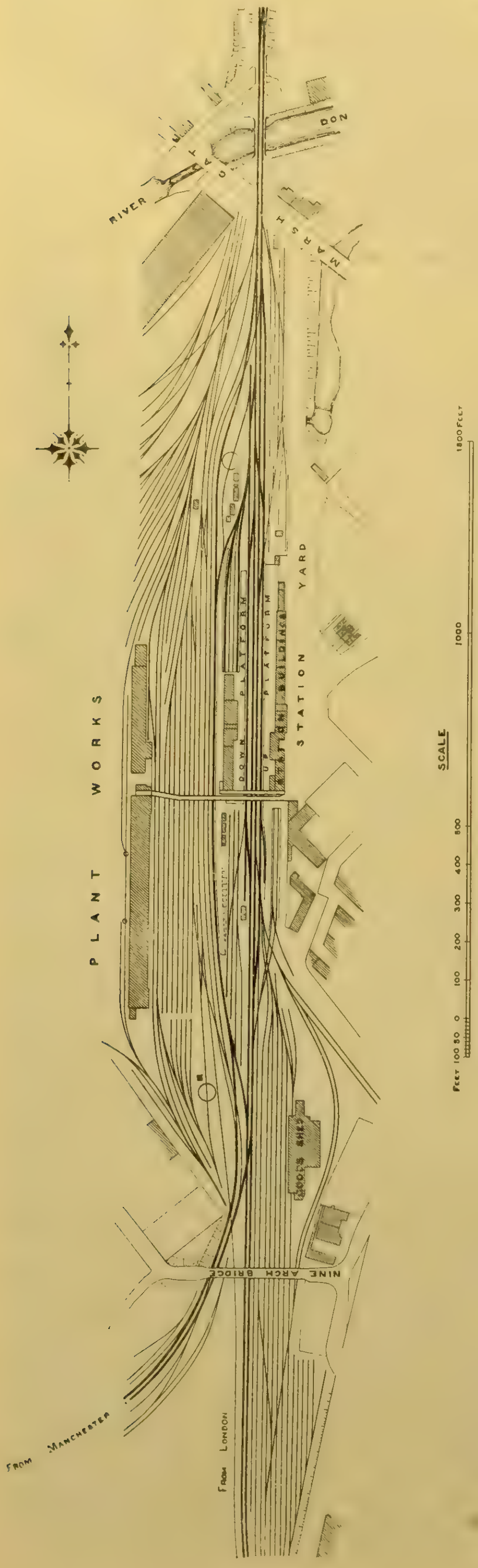


FIG. 15. GREAT NORTHERN RAILWAY STATION AT DONCASTER.

into it. It is a through, and essentially an island, station, as shown in Fig. 13. Between the up and down platforms there are six tracks, two in the open, and one of each of the remaining two sheltered by the roof covering the up and down platforms respectively, as clearly indicated in Fig. 13, which is a view of the station looking north,—that is, down the line. The outer columns supporting the roof must of necessity be placed on the formation level,—a somewhat unusual position, as it is preferable to put them on the platforms. In the latter case they may cause some inconvenience to the traffic, but there is no danger of either engines or trains coming into collision with them. The lighting is central, being over the platforms, where it is most wanted. The inner columns of the roofs are erected on both the up and down platforms shown in Figs. 14 and 16, and looking up the line. On the up platform the columns are in front of the booking-office and the other station buildings, and the intermediate space is covered in by a small roof resting on the main columns and the side walls. Upon the down side there is no small roof, an uncovered dock platform being provided for trains.

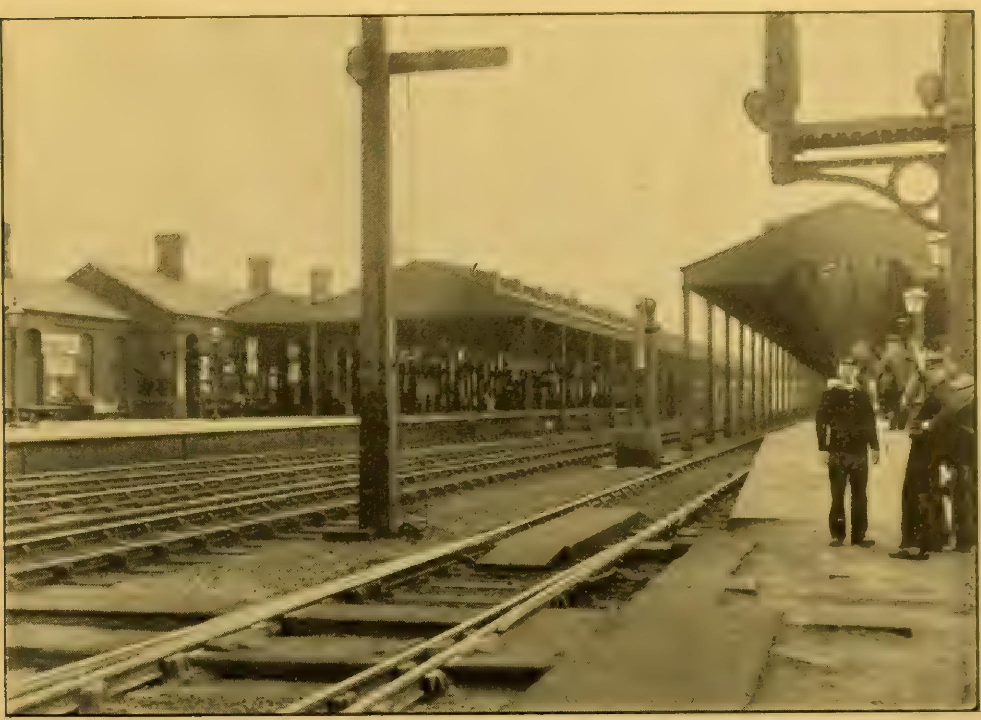


FIG. 16. DONCASTER STATION, GREAT NORTHERN RAILWAY. LOOKING SOUTH.

There are three general principles upon which the roofs of railway stations can be constructed. The whole area—that is, all the tracks entering and running through it—may be under cover. Again, some of them may and some may not. Thirdly, they may all be in the open.

As a rule, terminal stations must have continuous roofs, notwithstanding their heavy cost; but with through stations, especially when of moderate dimensions, the necessity is not so imperative. The Doncaster station roof belongs to the second type. At present there is a strong tendency to carry the third principle to the extreme, roofing in nothing but the platforms. It is alleged that, by the adoption of this method, considerable economy is obtained, and all the disadvantages attending the escape of steam and smoke in the station, instead of in the open air, are avoided. There is a good deal of force in these statements, for all engineers are aware of the serious and rapid deterioration, frequently the precursor of destruction, of all iron and steel work exposed to the corrosive influence of such agents. Anyone who has watched an engine brought to a halt underneath an iron bridge, and forced to remain there for some ten minutes, or perhaps longer, directing a continuously vertical fire of steam and other noxious vapours, under considerable pressure, against the structure, will cease to wonder why an extra thickness is given to the plates and bars of metal so ruthlessly attacked.

SEA-GOING RAFTS ON THE PACIFIC.

By Edward K. Bishop.

IF some ship-builder of old, with the lines of his primitive vessel in mind, could survey the oceans now, he would doubtless be as much amazed at some of the strange craft putting to sea from the Columbia river as at the modern warships or ocean greyhounds. In truth, many builders well acquainted with the present systems of marine architecture and engineering would view for the first time such craft, while the layman might hesitate before deciding whether to pronounce them monsters of the deep or some freak in ship-building. They can hardly be classified as ships, even though designed to go to sea, or as barges, though great freight-carriers; they are, in short, huge rafts, of round timbers or lumber, bound by cables, chains, and bolts in a scientific and ingenious manner, the method of construction having been evolved after many experiments in this little-tried field.

For several seasons past, rafts of logs have been towed to San Francisco, and the journey has been completed in safety a sufficient number of times to demonstate that the method of transportation is practicable as well as profitable. This year rafts composed wholly of lumber, and of totally different construction, have made their appearance, and every one interested in lumber or the carrying-trade on the Pacific coast is watching the experiments with great interest, as the establishment of this method of transportation would revolutionize the coastwise carrying-trade, and, by its great saving in cost, drive the sailing vessels and steam schooners out of business, or force a large reduction in charges.

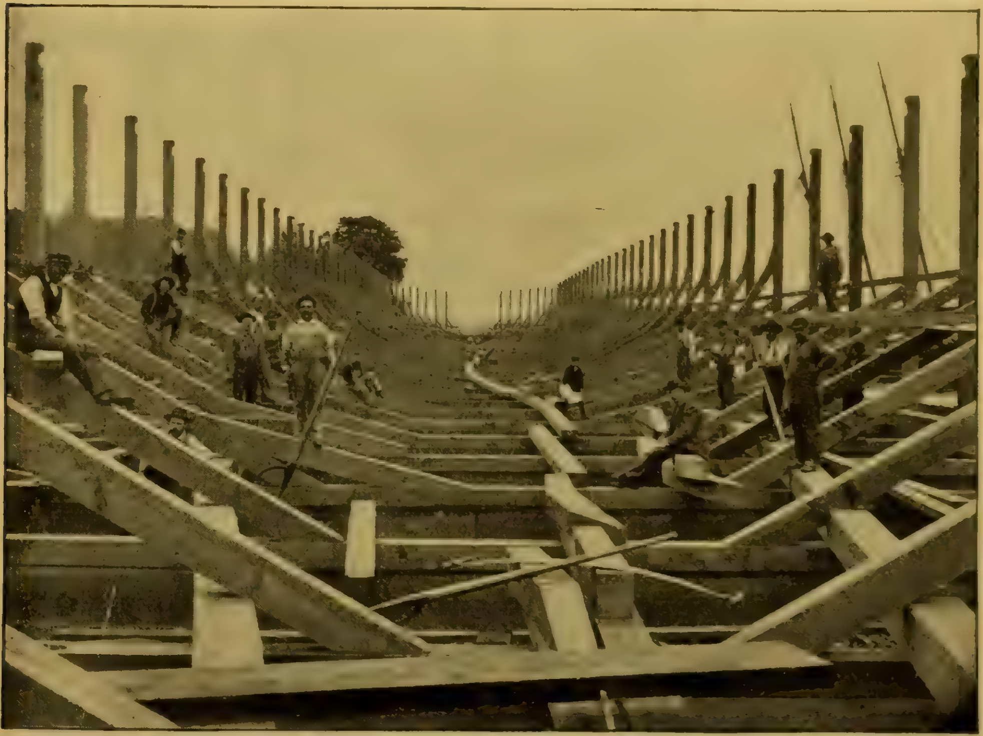
Both log and lumber rafts are still looked upon as objects of curiosity on the Pacific coast, and more or less the projects of men who will take great risks. The former operates in a comparatively restricted field, and will probably never change existing conditions to any great extent, as many think the lumber raft is destined to do; but it has already stood the test of several seasons, and the methods of its construction will be treated first.

Ten years ago considerable attention was directed to the first raft of logs ever built for an ocean trip. It was towed from the Bay of Fundy to New York city. Since then, a number have entered that harbor, but at the present time the centre of activity in this line is on the Pacific coast of North America, where a company has been incorporated for the express purpose of transporting the timber of

Oregon and Washington to San Francisco by means of rafts. The problem of incorporating material as unpromising as round logs into a vessel sufficiently stanch to make an ocean trip of 650 miles is a peculiar one, and few have seen the actual work of construction.

In contrast to ordinary boat-building, the cradle for this unique vessel is constructed on land and launched, leaving the work on the raft itself to take place in the water. The usual process of launching a completed vessel is replaced by drawing certain pins, causing the entire cradle to separate into two parts and allowing the raft to float freely in the river. At a short distance it then closely resembles one of the modern whalebacks, without any upper works, though a little closer inspection reveals the corrugated surface formed by the logs and the huge chains encompassing the whole. The timber composing it is of fir, and is chiefly for piling purposes and spars. No sticks shorter than 30 feet are used, and many measure 110 feet.

The cradle is composed of forty-three inverted bents, twelve feet apart, and the logs extend twelve feet over at each end, making the completed length 528 feet. The posts of the bents are 8 × 10 timbers ; with caps, 10 × 20. The desired contour for the bottom of the raft is secured at each bent by 30° and 60° bearers, supplemented by gluts designed to produce a form as nearly circular as possible. The various bents are joined together longitudinally by a series of

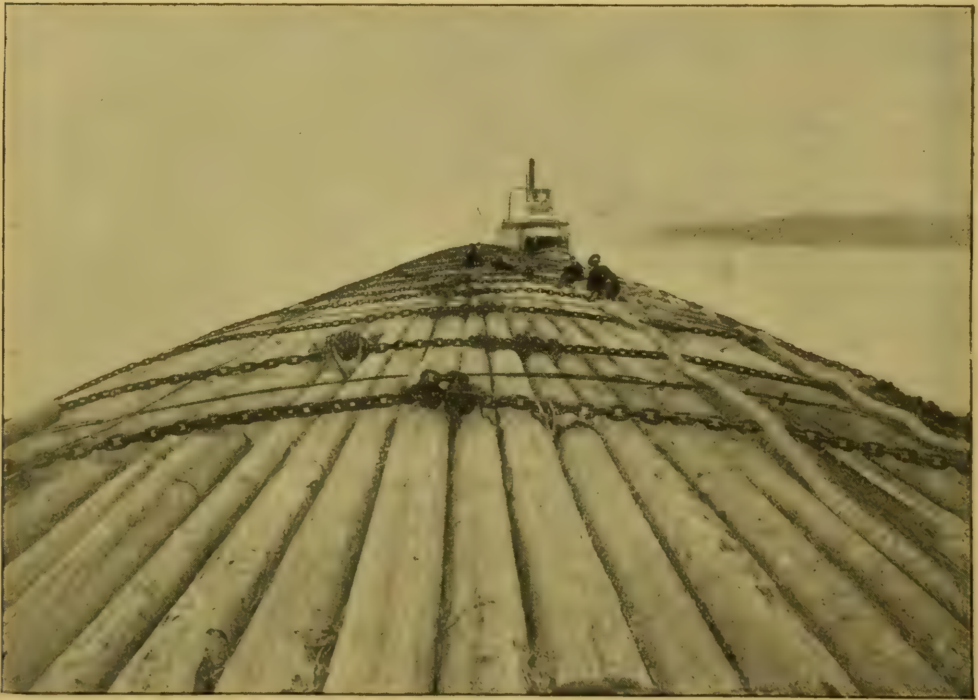


A CRADLE IN PROCESS OF CONSTRUCTION, BEFORE LAUNCHING.

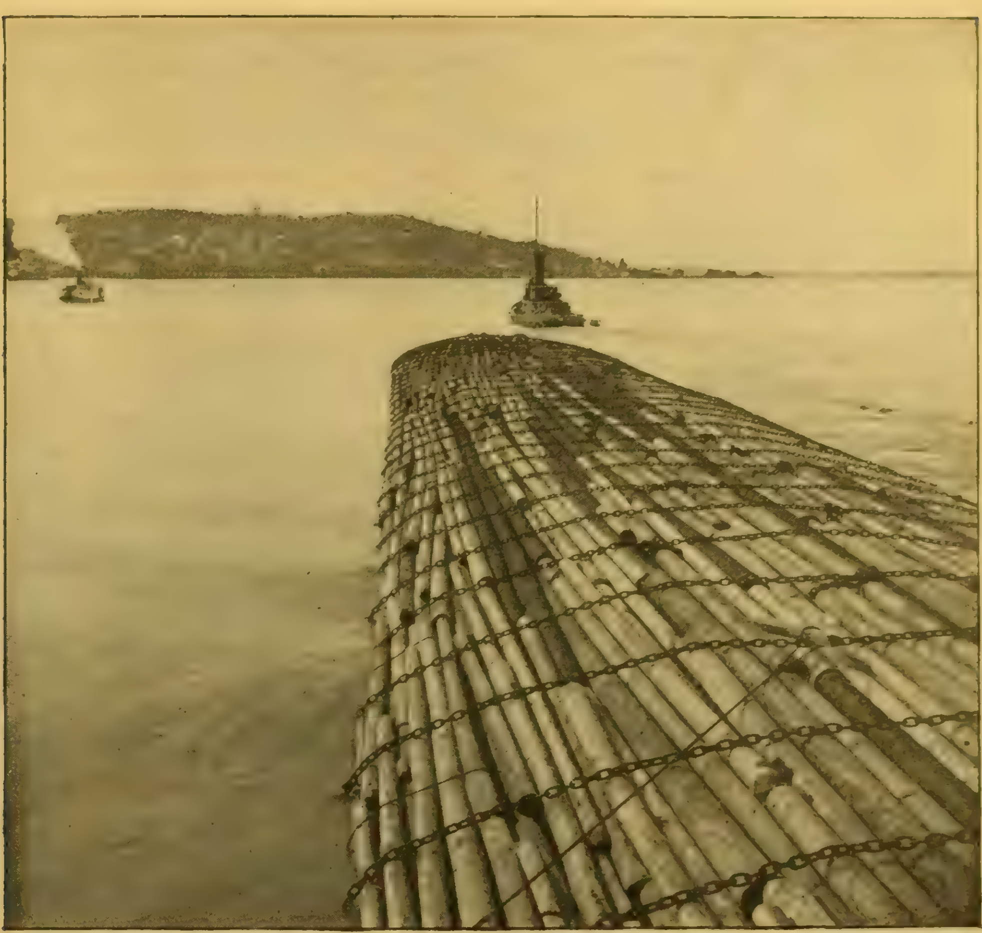
12 × 12 timbers, or waling,—six altogether, four being at the bottom and one on each side.

As already stated, the construction allows the final separation of the cradle into two parts, the line of cleavage corresponding closely to that of the keel of a boat. The division is rendered possible by the manner of joining the posts at each bent. One post is bolted to the 10 × 20, mentioned above, which extends the entire width at the point considered, while the other is fastened at right angles to an 8 × 10 and a 3 × 10, strapped together, with sufficient space left to allow the 8 × 20 to slide between, and long enough to reach half the distance between the posts. Thus it will be seen that the two sides of the cradle are entirely distinct,—the connection being made by sliding one timber into the channel formed by the other two,—and can be made into a rigid whole only by fastening the sliding member so that no motion is possible. This is done by pinning the three pieces together by a two-inch iron rod, so arranged that, when the raft is completed, power can be applied to withdraw each pin. Upon such withdrawal the cradle slides apart, releasing its burden.

When the cradle has been built and launched, it is towed to the desired location,—which in the Columbia has been in fifty feet of water near the mouth of a slough,—and is fastened in its place by a row of piling on one side, each pile passing through a tie box, connected with a bent, which allows the cradle to rise and fall with the tide,



A RAFT UNDER TOWAGE.



RAFT BEFORE ASTORIA, AT THE MOUTH OF THE COLUMBIA RIVER.

and also to sink deeper as the load increases. When completed, the raft draws about twenty feet of water.

In order to bind the raft together, the constituent piling must be very carefully selected. No swell butts or crooked sticks are accepted. The minimum length of a pile is thirty feet, and the butt must not be less than twelve inches or more than fifteen inches in diameter. Even with such timber, it is a source of wonder that a raft can be built to stand the ordinary swell of the ocean, not to mention the heavy seas frequently encountered, until it is noted with what care each piece is fitted into place, and the whole chained so that the pull on the towline actually binds it more firmly together. The logs are brought beside the cradle, where two large steam derricks, built on scows, are placed to hoist them into position inside. The raft grows, piece by piece, till the cradle is completely filled, when it is ready for the chain work which is to bind the whole together.

In form the raft closely resembles a cigar with each end cut off. It is designed that a section taken at any point should be a circle, but in practice most of the upper face is somewhat flattened. Each end is a perfect circle, twelve feet in diameter, and the size gradually increases till the width is fifty feet. After the raft leaves the cradle, its shape is maintained by chains, made of 1¼-inch iron, encircling the raft at intervals of twelve feet, and by wire cables running both longitudinally and transversely. The termination at each end is a stout bulkhead of four-inch plank, spiked to the ends of the logs. Outside of the plank are two upright round timbers, and the double cable, extending the entire length of the raft, joins the corresponding timbers together. The transverse cables connect the encircling chains a little below the water-line, thus preventing the raft from spreading.

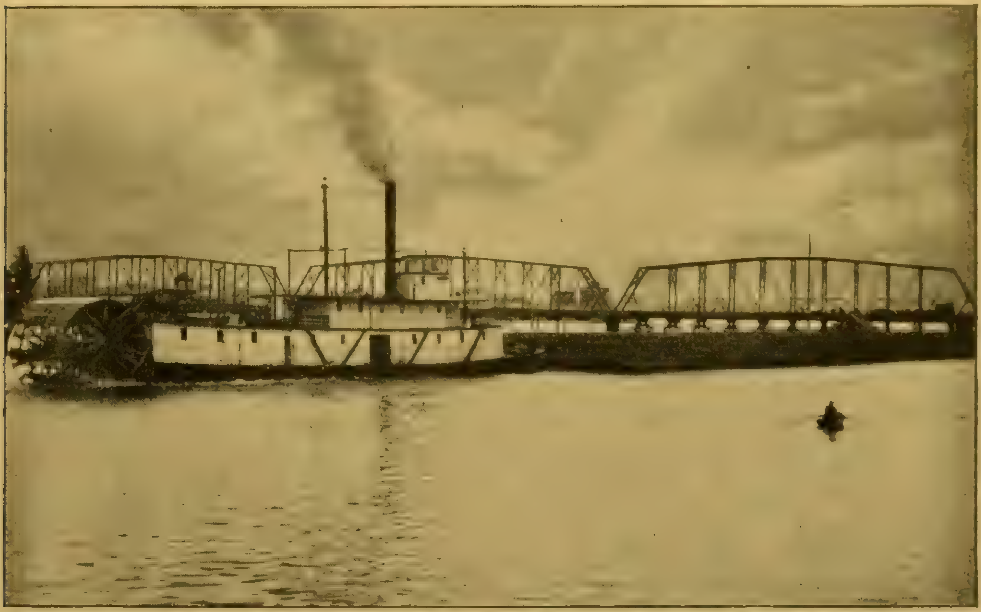
GOING OUT TO SEA.

The method of connecting the towline to the raft is ingenious and effective. Through the exact centre extends a heavy chain of 1¾-inch iron, with a series of smaller chains attached at regular intervals and connected by shackles to those encompassing the raft. Near the middle these chains extend at right angles to the centre line, alternately on one side and the other, except in the case of the last five at each end, where the circumference of the raft is rapidly diminishing, these being arranged in even pairs and slanting sharply toward the bulkheads at the ends, in a regular herring-bone plan, before joining the outside bands. Thus, when a pull is exerted on the towline, it is transmitted to every chain encircling the raft, and the heaviest strain will come on the rear end, which can better stand it. The logs can not escape, as they are bound by the circles of chain and the increasing diameter of the raft exactly as are the staves of a barrel when an attempt is made to draw the hoops over the centre. The amount of chain used is about eighty tons.

The completed raft contains 450,000 lineal feet of timber, or in the neighborhood of 3,000,000 feet, board measure. The average length of the piles is 55 feet, and the average diameter at the butt 14 inches. The spars are of special dimensions.

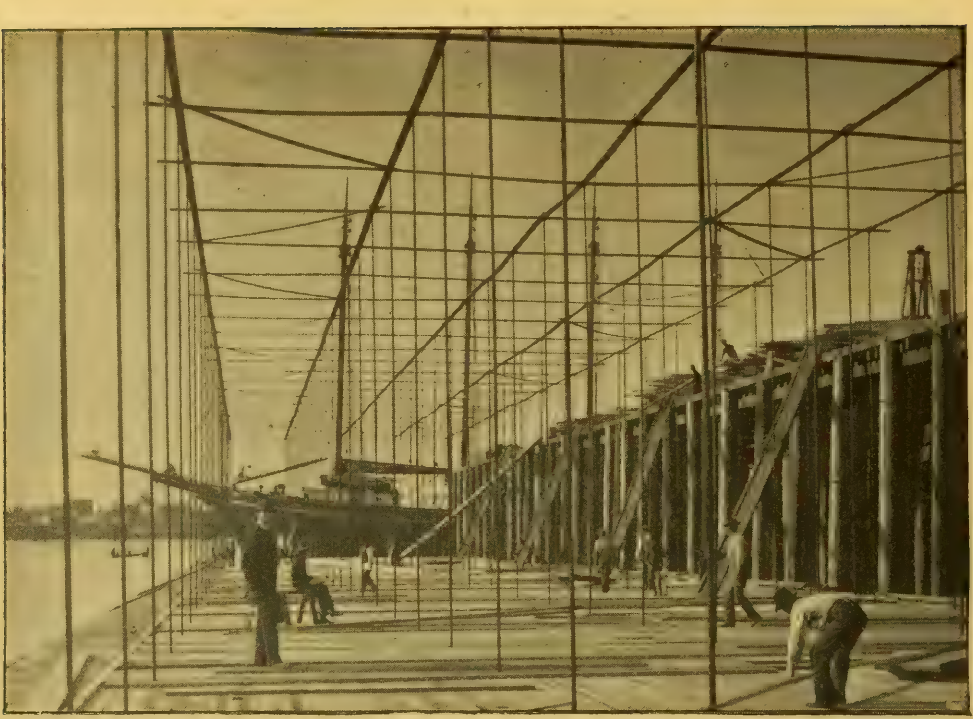
Auspicious weather is almost essential to a safe voyage of one of these unwieldy rafts, and they put to sea only at a time of year when storms are infrequent, though they successfully pass through weather much heavier than any that one would expect them to survive. In tow of an ocean steamer, the trip to San Francisco is made in about seven days. Several rafts have been taken out of Gray's Harbor, Washington, and this year will see the fifth start from the Columbia river. The first raft, in 1894, encountered a severe storm and went completely to pieces, but the succeeding ones reached their destination safely.

The shipping interests would gladly see the business discontinued, as there is always danger of several thousand logs being released on the face of the ocean,—a great menace to the safety of vessels whose course lies in their vicinity. The risk which the owners assume when they put many thousands of dollars into such a venture will be more potent in keeping the number of rafts from becoming large than the fears of captains; but the method of transportation is so economical that doubtless considerable quantities of the piling used in the neighborhood of San Francisco will find its way there in this form.



LUMBER RAFT LEAVING PORTLAND, OREGON, IN TOW OF A RIVER STEAMER.

Captain Robinson, who was interested in the first raft of logs built on the Bay of Fundy, and who is in charge of those constructed on



ARRANGEMENT OF BOLTS AND METHOD OF PLACING LUMBER IN RAFT-BUILDING.

the Columbia river, has patented his methods of building the cradle and of placing the chains.

The first raft of lumber built to make the sea journey to San Francisco was constructed at Portland, Oregon, by Inman, Paulsen & Co., and left the Columbia river June 24, 1898, in tow of two tugs. It encountered a storm, and the wind, blowing at the velocity of seventy miles an hour, finally produced a sea which broke the raft in two. The fragments held together for two hours after the back of the raft had been broken, and finally one tug towed the forward part into the harbor of San Francisco, while the other succeeded after a time in picking up the remaining portion and towed it to the same port in safety. Only a tenth of the lumber was lost.

R. D. Inman, who accompanied the raft to study the action of the sea upon it and gain ideas for improving its construction, is convinced that lumber rafts can easily be built to endure any but the severest weather. The proprietors are not in the least discouraged by this partial failure, and at the present writing a second raft is well under way. With auspicious weather there is no doubt that the journey will be made in safety.

The raft which started in June contained 5,000,000 feet of lumber, and was 396 feet long by 53 feet wide. It is difficult to realize the immense quantity of material incorporated into this raft, though a comparative idea may be gained by considering the fact that the average capacity of large ocean-vessels is little more than 1,000,000 feet.

Portland already has the distinction of loading the largest cargo of lumber that ever left the Pacific coast, which was won last year when the Glenlochy took 3,000,000 feet of railroad material to Siberia. Now, to pile Pelion on Ossa, the new rafts appear.

The idea of shipping lumber in this way originated with Johan Paulsen, a prominent lumberman, whose attention was attracted to the subject last winter by the difficulty of securing vessels to take lumber to San Francisco, owing to the fact that the majority of those available had entered the Klondike and Alaska trade. Doubters scoffed at the idea of transporting lumber in such a form, but the long years spent by Mr. Paulsen in the lumber business had included experience in rafting on eastern rivers and lakes, as well as on the Baltic; so, after looking at the project from a scientific standpoint and carefully considering all the difficulties connected with it, he concluded that a method of construction suited to an ocean trip of seven hundred miles could be evolved.

The raft projects very little above the surface of the water, and this greatly increases its chances for a safe trip, as the waves wash completely over it, encountering little resistance instead of expending their force in battering it to pieces. This is a principle used in the construction of the famous whalebacks, and one which experience has proved to be valuable.

The first step in constructing this late arrival among the various types of marine architecture is to select a dock, or drive a line of piling, four hundred feet long, as the basis of the work, and to supply a straight edge for the side of the raft. A stringer, or what might be termed a keel, is built for the entire four hundred feet by fastening together five layers of two-inch plank with ends butted so as to ensure the greatest strength. Five of these stringers are made, and placed something like huge joists, ready for a floor, and are then planked over crosswise, making an immense platform 396 feet long and 53 feet wide.

The bottom of the raft is now made, and the next step is to pierce each stringer, or joist, at intervals of twelve feet, and insert a long and heavy wrought-iron bolt, fitted with washer and nut below, certain planks being left loose up to this point, to allow their adjustment. The platform, which at first looked like a large dancing-floor, is now so changed as to resemble an orchard with long rows of spindling trees. The purpose of these rods can be seen after the lumber is put in.

First, a layer of lumber is placed lengthwise; next, another crosswise; and so on, till a pile twenty-one feet deep is made, the raft gradually sinking as the load becomes heavier, and about a third projecting above the surface all the time. The rods serve to connect the bottom and top, and bind the mass into a homogeneous whole.

A very liberal factor of safety is allowed, as the aggregate strength of the 170 rods would support a weight of 25,000,000 pounds, while the weight of the completed raft is only 15,000,000 pounds out of water, and much less when submerged.

The completed raft is encircled lengthwise by a 1¼-inch cable, to furnish a secure hold for the towline. The cable is of plow steel, and its strength is equivalent to that of a 14-inch hawser.

Before construction was commenced, a prominent marine underwriter was approached in regard to insurance. He admitted that the danger of loss was not nearly as great as many people would suppose, but predicted that the promoters of the project would encounter difficulty in insuring the raft, because it is so radical a departure from the orthodox methods of transportation, and because, if successful, it would have a far-reaching effect upon the lumber-carrying trade on the coast.

Mr. Paulsen has applied for patents on his novel lumber carrier, and he expects his raft to occupy a place beside the whaleback, which was at first an object of ridicule.

An important feature in the construction of the raft is that only an insignificant percentage of the lumber is injured by nail- or bolt-holes, and even this can be utilized for firewood in California.

One of the principal objections brought against rafting is the probable staining of the lumber by immersion in the muddy current of the Willamette river and the salt water. Many claim that the concession in the price of the lumber which will have to be made on this account will balance the saving in freight charges, and say that at best only low-grade stuff can be so shipped to advantage.

Rafting of this kind is still in the experimental stage, and it is early to predict the ultimate result; but, as this method of transporting lumber is only about half as expensive as the old, it is safe to assume that there will be a strong effort to make it a permanent success, and that the lumber trade of California and the Pacific northwest of America is likely to feel the effect of sea-going rafts.

THE EFFICIENT USE OF STEAM AND LABOR IN ISOLATED PLANTS.

By Percival Robert Moses.

PRESUMABLY every one knows what "efficient" means by itself, but, when it qualifies other words, its significance is not always clear. Nine engineers out of ten will say that a plant is highly economical and efficient if it has a compound engine, or pump, or both. Frequently, however, such a plant is of little efficiency. Efficiency in the operation of a plant depends more on the proper arrangement of the parts and the distribution of their work than it does on the correct design of the separate machines. It will approach a maximum when all the parts are economical, and when the waste of fuel-energy and the fixed charges of capital and labor are reduced to a minimum. This, like most truisms, is understood, but seldom applied. It seems as if, with economical parts, little fuel-energy would be wasted, but further consideration shows that such is not the case. For example, the best central-station plant equipped with high-pressure water-tube boilers furnishing steam to expensive triple- or quadruple-expansion engines, directly connected to generators of the most modern design, and with feed-water heaters, economizers, condenser, etc., utilizes less than one-third of the heat energy transmitted from the coal to the steam, the remainder being lost in the latent heat of the exhaust steam; while an isolated plant with a small fifty-h. p. engine using low-pressure steam in single cylinder only, with no condenser or expensive appliances, will, with a correctly-designed heating system, utilize more than seventy-five per cent. of the heat energy during a large portion of the year, and show an average percentage for the whole time greater than that of the central-station plant. It is the old Roman parable of the patricians and the plebeians—the belly and the members. They may be the best of their kind, but they are worthless unless they work together. To carry out the comparison with the human plant, the stomach may be considered as the boiler, the heart as the engine, and the other organs as corresponding to the laundry, ice, elevator, and other incidental machinery, neglecting for the present the closer identification of the parts. Nature is a remarkably efficient operator, and in no case do we find several stomachs supplying a number of hearts, each in turn supplying a separate organ; on the contrary, a single source pumps blood to all the organs. Each entity has a complete plant, but each plant is centralized. In the same way, in a machinery installation there should be one source of energy and one apparatus for transforming and transmitting the power, and all the operations pertaining to the building should be supplied from this source.

Mr. White, in the transactions of the American Society of Naval Engineers and Mr. Shepard, in THE ENGINEERING MAGAZINE for May, have brought clearly to notice the almost incredible waste due to the multiplication of small prime movers, or engines, on board the modern warship, and Mr. Stanwood, in the same number of the magazine, in his discussion of the "Economical Use of Steam in Non-Condensing Engines," shows the futility of attempting economy where a number of separate small engines are supplying widely-varying loads. Many American hotels are shining examples of conditions more wasteful than those aboard ship. In these we frequently find gas used for lighting some floors, and electricity for lighting others, both being bought; ice and refrigeration are also purchased; steam is obtained from boilers for running wasteful steam pumps, for elevators and water-supply, laundry engines, tool engines, kitchen engines, and engines for every little thing that has to be turned, each one seemingly more hungry for steam than the other. In addition, attempt is seldom made to use this steam after it has passed these engines, but more high-pressure or reduced-pressure steam is used for heating the house, the dry rooms, and the steam cookers. If these are the facts, what do they mean? They mean that the hotel owner, with a plant of the sort described, is burning twice the coal in winter that he should; that, besides paying the wages of his own engineer and assistants, he is also paying his share of the wages of the ice company's engineers, of the electric company's engineers, of the gas companies' engineers and their assistants, of their profits, of their rents and taxes, and of their other expenses, which together amount to more than ninety per cent. of their total cost and of their several coal bills, which, as they do not "use their steam efficiently," are each larger than his would be if all the functions were combined in one plant. This system is evidently wasteful, and the remedy must be present.

Briefly stated, it is, in my opinion, that efficient and economical operation of a plant can be obtained only when all the supply-functions possible are combined and the power for their working is derived from a single source. A concrete case will show the meaning clearly, and, as that of a hotel is the most general in its character, it will be first considered. In a hotel the supply-functions are light, heat, power, refrigeration, and ice. Light is needed continually in the kitchens, laundry, store-rooms, offices, halls, and restaurants, and at night in all of these, except the laundry and store-rooms, and in the sleeping-rooms as well. Heat is used for warming the building, for the drying rooms and ironers, for kitchen purposes, for warming the water used to feed the boilers and that used for house purposes, and for local applications, such as curling irons, chafing dishes, and similar apparatus. Refrigeration is required for storage of provisions, ice, ice cream, and water. Ice is used for restaurant and bar purposes. Power is necessary for elevators, laundry machinery, tools, polishers, dish-washers, water pumps, and fans. All these functions should, if possible, be combined and supplied from a single source.

In the present state of the art, steam is the only means we have of supplying all from a single source, economically; gas will supply them all, but at an intolerable cost. To obtain the steam, coal will be burned in the fire-box of a water-tube boiler, generating steam at a high pressure. This steam should contain more than seventy per cent. of the heat energy liberated from the coal during combustion, and must be used at least three times, in order to extract these heat units and prevent waste. The primary use is to furnish power,—*i. e.*, to run an engine, utilizing from ten to fifteen per cent. of the energy and reducing the temperature of the steam to about 212°. This engine drives a dynamo, which in turn supplies power for the scattered apparatus above mentioned and for the refrigerating machinery; "high potential" electrical heat for irons, broilers, chafing dishes, and local applications; and—what is really the same thing—electricity for lighting. It may be said then that fifteen per cent. of the steam energy is used for light, electricity, and power. There remains to be furnished the heat required to warm the building, the dry rooms, the cooking apparatus, and the water. This heat, which has been aptly classed as "low potential," is obtained in greater part from the steam which has already done its first work in furnishing power. The secondary use of steam is, therefore, for warming, and, as more than sixty per cent. of the total heat received by the steam from the coal is used in this portion of the cycle, the importance of avoiding waste of opportunities for its use is obvious. The third use of steam is to become hot feed water for the boilers or water for ice-making. By the third and last operation the heat units remaining are returned to their original source, in the case of the feed water, and the cycle is completed.

Thus far the uses of steam only have been touched on, but the reasons for the divisions outlined are of importance. Steam, in its three stages of high and low pressure and hot water, has different potential capacities. At high pressure it can furnish heat and power, but at low pressure it can furnish only heat. It is manifestly inadvisable, therefore, to use, for the lower grade of work, steam capable of producing power. Steam at low pressure can heat, to the highest temperature at which it may be pumped, four to five times its weight in water. It is, therefore, wrong to use the low-pressure steam where hot water will serve, unless the heat given off by its condensation is usefully employed. These are the general principles; necessarily they are subject to modification in particular cases. For instance, for dry rooms, steam ironers, and similar apparatus, a temperature higher than that available with low-pressure steam is required, and the practice is common of using reduced-pressure steam direct from the boilers.

This is unnecessary and inadvisable. Better practice requires that the exhaust or low-pressure steam should be used, supplemented by high-pressure steam from the boilers, the combination giving the desired temperature. There are several similar compromise points, which need not be mentioned. This statement of the cycle of steam is presumably an old story to many, but it must be borne in mind if the importance of the general statement is to be realized.

Another factor of great importance is the influence of climate. In New York there are about seven months in which house-heating is necessary; during the remaining five the exhaust steam may be used for other purposes. The necessity of combining all the supply-functions possible will now be apparent. In the ordinary city hotel the required supply divides between winter and summer in about the following proportions. Steam heat; winter, 88%, summer, 12%; light, winter, 66⅔%, summer, 33⅓%; refrigeration and ice, winter, 40%, summer, 60%; laundry steam, winter, 55%, summer, 45%.

The proportionate amount of power required by each of the supply items varies largely with the character of the hotel. The following figures, obtained by comparison and elimination from eight hotels similar in character, will serve as an approximation. The hotels taken were those of the old-fashioned type. The modern tall structure will probably show larger percentages for light, elevator, and refrigeration, and a smaller proportion for the laundry, while the heating factor will be negligible. The proportionate amount of power allowed for light was obtained by multiplying the number of lamp hours by .6, thus approximating the amount of coal necessary to supply light from a private plant. This table shows the percentages of the total annual power used by each factor in each season and in the whole year. For instance, the light requires 18 per cent. of the total power,—12 per cent. in winter and 6 per cent. in summer.

	Winter.	*Summer.*	*Yearly.*
Light	12.00	6.00	18.00
Heat	13.50	1.30	14.80
Elevator	6.00	5.50	11.50
Refrigeration	6.00	9.00	15.00
Auxiliary Cooking	1.50	1.20	2.70
Laundry, kitchen, house-pump, etc.	21.00	17.00	38.00
Per cent. of total power used	60.00	40.00	100.00

I have not divided the laundry from the kitchen, etc., it being impracticable to do so, but a ratio of $\frac{3}{5}$ to $\frac{}{5}$ would not be far wrong. The large proportion required for refrigeration and ice is a little surprising, but the steady character of this factor causes it to almost equal that of lighting in power-consumption.

The exhaust steam from the electric-light plant suffices for steam heating and for heating the feed water in winter, leaving the exhausts from refrigerating and laundry machinery to supply the distilled water for ice, steam for drying room, etc. In summer the lighting is halved, and the refrigeration and ice are increased one half, the laundry decreasing slightly. The increased amount of exhaust steam caused by the larger refrigeration requirement about supplies the increase in distilled water for ice-making, and a large part of the steam released by the decrease in lighting is used for heating the feed-water for the boiler. If the refrigerating factor were absent (ice being bought outside), nearly all this exhaust steam would be wasted. If the lighting factor were absent (electric light or gas bought from a company), the steam for heating would have to be obtained from the boiler direct, sacrificing the value of its expansive power. If the heating factor were absent, more than sixty per cent. of the heat energy would be wasted in winter.

But not only is steam economised by this combination; the consequent lightening of labor and capital charges is an item of still greater importance. One set of engineers, firemen, and assistants will attend a complete plant as well as one that lacks a third of completion. Electricians, ice handlers, etc., will be needed for their especial branches, but the number required for the production of the energy only will not be greater. Nor will the capital required for the production of energy be increased, as it has been found almost invariably that a plant capable of supplying all the electric light required will be capable of supplying all the other requirements as well. This fact is due to the way in which the different functions ' sandwich '' in with each other, avoiding concurrence of their separate maximum points.

In buildings used for manufacturing the conditions differ, but similar results may be obtained. In these light is used for a couple of hours only, and principally during the winter. Power, however, is used for elevators, presses, and sewing machines; localised high temperature for irons, glue pots, candy formers, and such apparatus; and low temperature for dye vats, feather steamers, steam ironers, etc. Using the steam first for power to run an engine dynamo to operate elevators, presses, etc., and to furnish high potential heat and light, the load may be fairly equalized, and the exhaust steam will serve, as in a hotel, for heating the building, for dye vats, ironers, etc., and for the feed-water of the boilers. Frequently a storage battery will prove a profitable investment for night work and for equalizing the load. The author has had occasion to instal such a system in a ten-story building where previously electricity was bought by the tenants for lighting, elevator, and pump and motor service, and where gas was bought for lighting and localized high-temperature heating. A large boiler, too, was run in the basement at low pressure for heating, and a small boiler on the tenth floor for dyeing and steaming. Under the new system all these are supplied from the single source, with no increase in labor charges beyond the addition of a fireman. The question naturally arises: why stop at supplying a single house? Why not carry the principle to a number; in fact, where is the limit? The limit will be reached when the exhaust steam can no longer be supplied for heating, when the cost of street-crossing, insurance, or taxes, overbalances the benefit to be derived, and when the increased cost of labor is proportionately greater than the increased business. A plant of a certain size may be run by a unit-body of men, and any increase beyond this amount requires nearly the doubling of the force and a large increase in the capital employed. Each case has its peculiar points, which require careful investigation, and any general rule would probably fail at the first application. The unit in New York is generally, on account of insurance laws and for speculative reasons, a single building, but in many instances the unit could profitably include a square 1,000 feet on the side, and, with increase of concentrated tall buildings having similar needs, it could doubtless be extended further. The central stations for the supply of light or steam or ice separately met all the requirements when the buildings were low and spread over a large area, but the new conditions must, in the author's opinion, bring about a system of block stations and isolated plants with which the central station for a single item will be unable to compete.

REVIEW OF THE ENGINEERING PRESS

The Biggest Mine of All.[*]

He was a mining engineer,
Thoroughly trained in every sphere
Of knowledge scientific;
The catalogue of things he knew,
In theory and practice too,
Would cast a spell on me or you,
As something quite terrific.

Chemical unions he could loose,
And most refractory ores reduce
To reguline condition;
And, having conquered many lands,
He sought fresh triumphs for his hands,
When, walking on the ocean sands,
He felt a new ambition.

Before him in the sunshine rolled
The largest known supply of gold,
Though somewhat low-grade was it!
The stuff was soft and easily won,
And carried (said Professor Don)
About nought point three cents per ton—
A wonderful deposit!

And it was uniform, no doubt;
If it were mined, year in, year out,
With proper assiduity,
It would go on and pay to man,
As no mere land-deposit can,
The dividends it first began,
In endless continuity.

Besides, of such productive work
No "apex-right" or legal quirk
Could thwart the rich requital;
For everybody knows the sea
To everybody's use is free,
With neither rent nor royalty,
By immemorial title!

The sailor cleaves it with his keel
For cod or mackerel, whale or seal;
It yields the bather's toilet:—
Why should not the metallurgist,
On small or large scale, if he list,
A part that never would be missed
Abstract, and simply boil it?

"The scheme's complete!" he proudly cries
"It only needs that I devise,
"My skill profound displaying,
"Some process, either cold or hot,
"Thorough and practical, and not
"Too costly, which will give me what
"The wild waves are assaying!"

He built a wondrous structure then,
Which thoughtless, undiscerning men
Despised as hocus-pocus.
It held a monstrous burning-glass
Through which the solar rays would pass
To pierce the seething, sizzling mass
Of ocean at the focus.

And then there was a coffer-dam,
Which, inexperienced as I am,
I dare but slightly mention,
And wires electric—what their need
Or use, I cannot say indeed;
But they belong, it is agreed,
To every new invention.

When all was done, he calmly sat,
As some contented, stately cat
Sits gravely looking at us,
And waited for the fateful day
When he should reap the golden pay
Resulting from the opera-
tion of his apparatus.

The process turned out cheap but slow;
He saw the seasons come and go
With patient desperation,
While bravely he would still repeat
To all the explanation neat,
That his solution was complete,
But lacked precipitation.

His eyes grew dim, his hair grew white,
His creditors forgot him quite;
The speculative fever

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[*] Dr. Raymond's lines, which are given herewith in full. were read at the Atlantic City meeting of the American Institute of Mining Engineers and were suggested by the experiments of Dr. Don, of New Zealand, communicated to the Institute in a recent paper, and the other stories of the extraction of gold from sea water then, and since, current in the daily papers and the technical press. THE ENGINEERING MAGAZINE does not often emulate the example of Mr. Wegg, but in this instance is delighted to show its appreciation of the novel style of the honored Secretary's communication by presenting it in its completeness, rather than any comment which would lose the flavor of the original.—EDITOR.

Had ceased, except in him, to burn—
They did not even care to turn,
And get the leaky old concern
Attached to a receiver.

At last there came a stormy day
When a great wind laid bare the bay—
A most uncommon antic—
And what was more, the hurricane
Banked up the dunes along the main,
So that no drop came back again
Out of the vast Atlantic.

The aged mining engineer
At this catastrophe, I hear,
Was staggered for a minute.
But science was not long at fault;
After a transitory halt,
He mined that coffer-dam for *salt*,
And found a fortune in it!

R. W. RAYMOND.

American Export Manufactures.

THE remarkable change in trade movements, especially as between Great Britain and the United States, forms the subject of an instructive editorial in *Bradstreet's*.

From the figures presented, it appears that, while Britain's exports to countries other than the United States have remained practically constant for the last three years at about £215,000,000, the exports to the United States have rapidly declined in the same period from £25,697,000 in the fiscal year ending June 30, 1896, to £14,687,000 in the year ending June 30, 1898.

On the other side of the account, British imports of American products have increased during the same period from £91,332,000 to £123,399,000, while the imports from other countries have scarcely varied from £338,000,000 per annum.

Commenting upon this, the writer says:

"It is seen that practically the entire gain in British imports during the past two years has been in products of the United States, and the natural effect of this one-sided trade is shown in the fact that, while we bought to the extent of £14,687,000, we sold goods to the British of the value of £123,399,000, leaving a balance in our favor of £108,712,000, or $527,253,000, a sum which, it is safe to say, has never been equaled in our dealings with this or any other country or by any other year in our history.

"Naturally, such an enormous trade balance against them has been viewed with some concern by our British cousins, who have been anxiously looking for signs of a change in this very one-sided feature of international trade or barter. They comfort themselves, however, with the notion that the above showing is now history not likely to be soon repeated. With the return of peace they look for better trade in this country, together with enlarged buying abroad and consequent heavier sales of British goods to us. At the same time, with better crops in England and elsewhere, they look for necessarily smaller payments to America, and, in fact, a return to the normal in trade relations with this country. That British expenditures for American produce the present year are likely to be smaller than those of last will be conceded by many, but whether there will be a return of the heavy American buying, which was a feature of former years, will not be as readily admitted, and there are even some British observers who seem convinced that the development of American manufacturing industry will prove such as to permanently emancipate America from the necessity of ever again buying to the volume reached in former years."

There is no question that American industrial manufactures are not only able, but forced, to seek markets beyond the national boundaries, and that machinery and machine tools, especially, will henceforth appear as a considerable and rapidly-increasing item in the export trade of the country. But, in buying them, England is simply equipping herself with the means of cheap production which have given the American manufacturer his ability to compete with the older countries, and thereby placing herself in the best position to meet his competition, if such it be.

It should be observed, however, that with the rest of the world England has steadily maintained her full volume of sales. Every one familiar with industrial conditions there knows that her workshops are full to overflowing with work and orders, many of them for months—and even years—ahead. Many of her purchases of foreign machinery and supplies, indeed, have been dictated by the absolute inability of her own workshops to supply in time her own wants. The rapid opening of new countries, the development of their natural resources, the general rise in the standard of living everywhere—all these promise to tax by their demands the productive capacity of all the great industrial nations. To come nearer home, the neglected field of electric traction in Britain, so ably discussed by Mr. Knox in this number of THE ENGINEERING MAGAZINE, offers vast opportunities for the engineering trades.

Beyond all this is the yet undeveloped reserve productive capacity of the British workman, heretofore held in check by short-sighted labor-union regulations. The indications are strong that trade unionism in England must yield its foolishly-conceived position and make way for the methods of intensified production which characterize America and the continent; but there is small cause for England to be alarmed at her imports from the United States—especially her imports of the tools and, with them, the methods which are the means of cheap and rapid production.

Tall Buildings in Rome.

THE tall building is looked upon as so exclusively American that it is startling to be told that even in this the nineteenth century is not original. It is not, however, in this instance, the Chinese whose footsteps marked the earlier path, but the Romans. Prof. Lanciani, according to *Architecture and Building*, has discovered that there were building laws in Rome two hundred years before the Christian era. The steps seem to have been exactly similar to those recently witnessed : crowding of the population into the cities; enormous increase in price of urban property ; successive additions to the number of stories, in the effort to secure proportionate rentals; and, finally, interposition of the law-makers in the interest of public safety. Gloomy forebodings as to dangers from fire, speculations as to the menace from deterioration or decay of the structures themselves, and complaints of the darkened streets were familiar then as now. Nor is it surprising to learn that many of the plagues and pestilences are attributable to the dampness of the overshadowed streets and the exclusion of the sunlight.

"There are frequent allusions among the Roman historians, orators, and poets," says *Architecture and Building*, "to the enormous height of the tenement buildings of Rome, but no definite figures are given until the days of Augustus, when a law was promulgated by the senate which fixed the height of new structures at 60 feet on the street front, without making any allusion to the height of the rear. It is, however, known that in the rear these tenement buildings rose often several stories higher than in the front, so that from a distant height, as from the top of a temple which commanded an extensive view, a row of tenement buildings in Rome presented the appearance of a terrace—highest in the rear and descending by stories toward the front. The law of Augustus applied to new buildings, respect, then as now, being shown for investments already made. The number of stories on the street front of these Roman buildings was generally ten to twelve, with fourteen or fifteen in the rear. The lowest stories were 8 or 10 feet in height, but, from accounts given by the writers of that time, the stories appear to have gradually diminished as their height above the ground increased, so that the topmost tenants lived in quarters where very often they could not stand erect. That the stories were sometimes much less than 5 feet is shown by the discoveries in Pompeii, where, in a house inhabited, presumably, by poor tenants, a story of 4 feet 3 inches has been discovered. This was a living room, too, for in it were found all the articles which pertained to Roman housekeeping—cooking utensils, beds, stools, mirrors, combs, brushes, and other things which, with the bones of the family, furnished indisputable evidence that the rooms had been occupied. It is quite likely that there were thousands of rooms in the tenement districts of Rome that were no higher than this Pompeiian tenement, and, indeed, more than one Roman poet alludes to the lodgings into which he must 'creep,' the word, perhaps, indicating, not a figurative, but a literal, method of entrance. That the tenement houses of Rome towered at least 100 feet above the street in front, and probably 125 to 130 feet in the rear, is certain, for the promulgation of an edict limiting the height to 60 feet in front indicates that this height had been so greatly exceeded in so many cases that the public safety was believed to be imperilled. How many stories were contained in these tenements is conjectural, but, if the upper stories were no higher than that of the house in Pompeii, the Roman tenements may have contained as many or more stories than the modern office-building."

Perhaps it is only a completion of the parallel to be told that the building laws were continually ignored or evaded, and only Nero's celebrated and certainly sweeping methods secured, for a time, the abolition of the tall building in Rome.

Prof. Haupt on the Nicaragua Canal.

COURTESY to Prof. Haupt, and the desire, in the interest of fair dealing, to afford him the opportunity to defend his position, lead us to give space in these columns to his comment upon Mr. Nimmo's strong arraignment of the Nicaragua canal project, published in THE ENGINEERING MAGAZINE for August, 1898.

With due deference to Prof. Haupt and the other earnest advocates of the canal, the attitude of the magazine, as evidenced by its former publications on the subject, is one of dissatisfaction with the evidence so far offered as to the engineering feasibility of the scheme advanced, skepticism as to the commercial advantages of the canal, and strong opposition to the governmental espousal of the undertaking.

Prof. Haupt's rejoinder is as follows:

"On my return from a trip to the south my attention was directed to the supplementary article in THE ENGINEERING MAGAZINE on the Nicaragua canal by Mr. Nimmo, former statistician to the government, purporting to show why this great highway of commerce should not be built and introducing into his presentation personalities and opinions which seemed to be out of place in a magazine article. While I do not propose to enter into a controversy on this question and shall not lay stress upon his misquotations, I desire to state that, in reaching his conclusions, the writer has reiterated many erroneous premises which have been frequently refuted in the daily press, and has ignored the fundamental axioms of transportation, of which, however, he does not profess to be a master. The fact that he should have so unjustly misconstrued my computation of the increment in value of commerce, when the details of the calculation were so fully set forth, showing that I limited myself to a simple, and not to a compound, ratio, to keep within safe limits, indicated a bias intended to discredit a logical conclusion as to the great value of the economics resulting from this would-be canal. This class of argument merely tends to weaken the special plea alleged to be made in the interest of the transcontinental railroads. As a matter of fact, confirmed by experience, it is my belief that our transcontinental lines will be greatly benefited by the colonization of the Pacific coast which would result from the opening of this waterway.

"It is a striking illustration of the scope of the writer's perspective that he should limit the amount of the traffic to only 300,000 tons per annum, whereas a well-informed ex-governor of one of our western States predicts a traffic of 2,500,000 tons from coal alone, which would be new business for the canal. But it is not my purpose to discuss the commercial question; time alone will answer the doubts and predictions of both the advocates and opponents of the canal, for this great work, like all others tending to promote the general welfare of mankind, has its experiences, and a war of words will determine nothing. Current events seem to point conclusively to the consummation of the desires of centuries to unravel the secret of the Straits, and I believe our country is thoroughly alive to its solemn duties and obligations in the premises and will not hesitate to assume its responsibilities. May the crowning act of the century be the inauguration of the Nicaragua canal!"

The Opening of the Indies.

THE prognosis of a sudden expansion of manufacturing and engineering enterprise in countries heretofore stagnant or retrograding under Spanish rule, and the similar opportunities afforded by the new conditions in China, have been so often proclaimed and are so generally recognized that a mention of them is trite.

To the American, however, who has but recently begun to seek the broader markets of the world, the situation presents a more novel interest than to his European competitor who has long been familiar with corresponding ventures. The requirement is not an adaptation to incidental conditions, but to a new policy, for, while American influence will naturally be paramount in Cuba, Porto Rico, and the Philippines, it will be by no means exclusive. The Englishman and the German, long accustomed to seek an outlet in foreign countries, will be wide awake to the fresh opportunities and early and active on the ground.

The *American Machinist* aptly says: "It is not to be doubted that we shall receive the lion's share of Cuban trade. Even under Spanish rule we obtained a considerable portion of it, despite the discriminating duties in favor of the home government, which showed how superior would be the advantages of trade with us under equal conditions."

The point to be emphasized is that the conditions are much more equal, broadly speaking, than those to which the manufacturer in the United States has been accustomed in his home trade. The artificial elements will be largely eliminated, and the footing made approximately equal for all contestants. Even in internal relations, there is a strong tendency toward the belief that America is reaching the final stage implied in Garfield's maxim of "protection with a view to ultimate free trade," and, as to these newer fields, there is, as the *Machinist* says, "a disposition on the part of our Government to introduce the policy of the 'open door' in its dependencies or quasi-dependencies. Even such a strong tariff man as Mr. McKinley apparently recognizes the fact that the doctrine of protection of industries is inapplicable where such industries do not exist, and, if a liberal policy in this respect is satisfactory to the protectionists, *a fortiori*, it must be so to the free traders. Let us then rid ourselves of the idea that the West Indian islands are going to be an exclusive game preserve for us, and let us rather practise to increase our accuracy in bringing down birds of business in rivalry with the Germans and others who are good marksmen."

An instance of German methods in this style of hunting was recently afforded by one of the leading directors of engineering enterprise in that country, who stated that his house had sent to China two intelligent young men to study the language and two engineers to examine the opportunities for industrial work. At the end of a sufficient period, one linguist and one engineer would return to the home office, the others remaining in the field, thus establishing complete touch between the two ends of the organization.

The American, once he seriously undertakes the problem, will prove as skilful in adaptiveness as he has been in mechanical ingenuity, but he will need to possess himself of all that is best in the methods of all his rivals—and improve upon it wherever he can.

More Rail Joints.

AT the annual meeting of the American Society of Civil Engineers in January last Col. H. G. Prout introduced a resolution as follows: "That it is the sense of this meeting that a special committee be appointed to consider the subject of Rail Joints for Standard Steam Railroads, and to report to the Society certain joints for discussion, and that this subject be referred to the Board of Direction for its action."

So far, so good; but from the *Railroad Gazette* of August 19 we learn that, although the annual convention of the Society adopted this resolution to the extent of instructing that it be submitted to the Society at large in the form of a letter-ballot, it is to be feared from the tendency of the discussion that the resolution may reach the Society in an emasculated form—emasculated in that its scope may be confined to an investigation of angle-bar standards only.

If it were not that the Society is always so conservative in its action, it might be suspected that the intention of some members who took part in a discussion of the resolution was to draw its teeth ; for any investigation of rail joints conducted by such men as are absolutely essential to the framing of a valuable report should not be restricted to the examination of angle-bars only. If it is so restricted, its value will not be in the least doubtful ; it will be worthless. Furthermore, it is possible that engineers of wide knowledge and reputation will hesitate to take part in so fruitless a proceeding, and, without them to answer for it, the weight and force of the report will be gone.

This conservatism of the American Society, so admirable in its way as a rule for guidance, leads the society by its excess into strange methods, and, for fear that their transactions may be polluted with the name of a patented article, or because one of their committees may be brought into contact with proprietary devices during the course of an investigation, they find themselves estopped from acquiring many desirable and useful facts. Nevertheless the back pages of the "*Transactions*" are devoted to advertising.

Neither the writer nor (probably) any member of the Society wishes it to recommend any special or exclusively-owned form of rail joint, but there may be, and very likely is, a patented joint which best embodies the principles of a thoroughly successful one. If so, the committee should test it in every possible way and include their deductions in their final report; to follow any other course would be to disappoint the members of their profession. For the duties of this body,—the American Society of Civil Engineers,—are not confined to the roll of its own members, but extend to many thousands of outsiders, ineligible from the force of circumstances, but vitally interested in the subjects of the Society's deliberations.

What is the best form of rail joint to meet the conditions obtaining on our railroads? That is the question. Angle-bars play but a small part, and, in the opinion of many engineers who are well qualified as judges, a lessening part, in the matter as a whole.

The very use of the term in the discussion is enough to prejudge the decision in some minds. The angle-bar is only one of many means for joining the ends of two adjacent rails, and to investigate angle-bars only as angle-bars, and not as members of a large class, would be to start at the close, instead of at the beginning, of the subject.

But, if the work of the proposed committee is to be thoroughly done, it has a long and hard road to travel before it can decide on what is the best form of rail joint. What is the best part of the rail to which to apply the pieces composing the joint? What shall be the general arrangement of these pieces? What are the forces of impact which must be met? Shall the joint be supported on one, two, or three cross-ties? What is the proper distance apart for these ties for different weights of rail? How do the quality and depth of the ballast affect the behavior of the joint?

And then, after all this is known (it is not *known* now—some of it is guessed by a few shrewd men, but it is only guessing at best)—after all this is known and the best joint is decided upon, the committee will be met with the question whether joints should be used in the main track at all, except in rare instances—as, for example, at frogs and switches. Has not the time come already for continuous rails, riveted, welded, or cast together?

Here is a considerable field for investigation, and, without a carefully-weighed decision on each of these and many other points, reached only after the most intelligent experiments, the final report may well do more harm than good.

The work of the committee on standard rail sections, difficult though it may have been, was child's play beside it, and one may well shrink from the responsibilities and labor connected with the search. Nor can the work be done without a considerable expenditure of money. Many pieces of track embracing various sorts of traffic must be maintained in different parts of the country. They must be closely watched, compared, and recorded, and this cannot be successfully done except by men who are under the authority of the committee.

In the track experiments the committee will undoubtedly have the financial and moral coöperation of many railroads, and it will also command the experience of any one whom it may choose to call upon; but still its labors will be immense, and it must be years before it can make a report.

Col. Prout has started a very innocent-looking ball rolling, but, before it is safely lodged in the archives of the Society, it may develop into a first-class planet. He has, however, suggested the only way by which this complicated question can ever be intelligently formulated and discussed. It remains with the Society to see that it is properly entered upon and carried through.

Garbage Disposal.

THERE seems to be, as yet, no consensus of opinion, at least in American cities, upon the solution of the problem of the most sanitary and most economical method of garbage disposal. One great difficulty probably lies in the widely-varying conditions to be met in different localities. The differences are partly natural, as for instance the very important elements of city plan and topography, affecting the cost of collecting, which is a large item; the distance to which, and means by which, the collected garbage is transported to the disposal works; the existence or non-existence of a local market for the possible products of recovery, which are of low grade and will not bear the costs of carriage to any considerable distance; and the ruling prices of fuel and labor. Again, some very important considerations are in a sense artificial, arising from the wide differences in local usage or regulation (for it is commonly a matter of municipal legislation) as to what constitutes the garbage of the city.

The tendency, however, is very strongly toward the withholding from the garbage, in more concentrated form, of the formerly considerable by-products which gave it commercial value. These are grease, and animal waste carrying nitrogenous and phosphatic compounds which are useful as fertilizers. The close study of economies in the establishments which were formerly the greatest waste-producers has brought about a change in methods by which the marketable materials are recovered before any fermentative or putrefactive process has set in. Indeed, it is facetiously said that nothing now escapes unused from the great "packing houses" of the west except the squeal of the hog and the curl of his tail. Naturally concurrent with this movement has been a great decline in the selling-price of such by-products.

It may be taken for granted, therefore, that the "reduction" or destruction of city garbage is not, *per se*, a commercially-profitable undertaking. The point is worth making, because many schemes have been urged upon investors under very different representations. It is on a par with street-cleaning—the profit to the contractors is the margin between the sum recovered from the city and the cost of the disposal. And the recoverable products are so small, in proportion and in value, that only in special instances will they justify any "process" for saving them. In the great majority of cases, to attempt it is to imitate the man who burned a sixpenny candle looking for a lost pin.

The future will probably see the general adoption of a simple, well-designed furnace for destroying the garbage by burning. An admixture of a portion of the city ashes might help mechanically, and very possibly furnish enough unburned coal to carry on an active combustion without any other fuel.

The naphtha-extraction processes which

were so energetically exploited some years since seem to have dropped into a merited oblivion, and the day of steaming-and-pressing methods is here.

The Engineering Record furnishes descriptions of two large installations on the system, the first of which, on Barren Island, is especially interesting because it is the largest undertaking of the kind in the United States. During the summer of 1897 the maximum amount received per day was about 800 tons, but considerably less is reported as being received during the corresponding months of the present year. The striking difference has not been satisfactorily accounted for.

"In the original plant there are two lines of digesters, each containing 24 units; each digester is 6 feet in diameter and 15 feet high, with charging holes in the center of the top and discharging holes in the center of the bottom, with steam-pipe connection for live steam for cooking the garbage and for exhaust steam led away to the condenser. The garbage is cooked from 8 to 10 hours at a temperature of about 310 degrees F. under 60 to 65-pounds' pressure per square inch, after which it is discharged by gravity into the receiving tanks, of which there are 12, each 7 feet high, 14¼ feet in length and 12½ feet wide, each receiving the cooked garbage, called tankage, from four digesters. Each receiving tank discharges its tankage, when required, into a press immediately under it, having a 4 × 5 platen, operating with a pressure of about 100 pounds per square inch. The charge for a press-full is disposed between crates in thin layers, 16 in number, each confined at the edges by canvas bagging. The liquid effluent from the presses is run through a series of 10 grease tanks, which permit the cooling and the skimming of the grease, from the last of which the liquor is pumped to the evaporators, where it is reduced to the consistency of thick syrup and is called 'stick;' this is now added to the dried fertilizer to enrich it, though formerly, and until required by the board of health to do so, the liquor, after leaving the grease tanks was discharged into the waters of the Jamaica inlet on which the plant is situated. The solid residue remaining in the presses and called 'sludge' is taken in cars to the rotary dryers, large horizontal cylinders with horizontal axes, heated by live steam jackets, and the contents stirred continually, while drying, by a rotating shaft running through the center, carrying arms or paddles. The steam and vapors driven off in this drying process are led away to condensers by a slight suction produced by the condenser itself. Similar suction is applied to the exhaust steam from the digesters, and to the evaporators used in reducing the press liquor to 'stick.'"

The other plant described in the *Record* is at Detroit, and handles from 70 to 90 tons a day. The process is essentially similar to that just described—*i. e.*, the garbage is first cooked for seven hours with live steam and finally dried in steam-jacketed dryers, the resultant product being "about 15 per cent. of the original bulk, in a dry, homogeneous, brown powder." The peculiar feature of the process, however, is the intermediate step between the cooking and the drying. Instead of being put through presses at this stage, the garbage remains in the original tank, and "steam at a pressure of 80 pounds per square inch is forced into the tank from above and also from below. The liquid from the garbage is then forced out by means of the steam through a pipe under the perforated bottom. The steam pressure is continued on the tank for a period of four or five hours, during which time nearly all the liquid and grease are squeezed out of the material, leaving about 30 per cent. of the original garbage in weight in the tank."

This should certainly have a diagram.

The garbage contract has been so fruitful a source of political jobbery that great value attaches to any clear description of apparatus and methods which will dissipate the mystery so frequently thrown around the subject. If figures of amounts treated, yields, values, and working costs could be widely-spread, the reign of the jobber, in this field, would be at an end.

THE BRITISH PRESS

American Progress in English Industries.

THE manner in which articles of American manufacture are progressing in English markets is not fully appreciated by every one. A recent editorial in *The Engineer* calls attention to the rapid and continual growth in imports from the United States, especially of engineering products.

"A great deal has been heard of late about the progress of Germany as a rival to industrial England. So much has this been the case that the bitter cry of American competition seems to have been overlooked. All the same, it would not be far from the truth to say that British industry is pressed harder by the Americans than by the Germans."

Much of this is due to the superior efficiency of the American machines and the way in which they are worked by American workmen.

"In England the express purpose is to let the machine do as little as possible. There could have been no more striking example of this than during the late engineers' strike, the crux of which may be said to have been a resolute attempt to slow-time the machinery. In the United States the free use of automatic machinery is the chief factor in the different industries, the workman being anxious to beat the record in the utmost amount which can be got out of his machine. One man may be found looking after half a dozen machines, and even boys are often seen working in the same capacity."

Apart from questions of cost, and the influence which economical production has on selling price, the superior quality of the product often causes British manufacturers to use American products, when their preference otherwise would be for articles of home manufacture.

Examples of this sort of thing are found in malleable-iron castings, which are of such a quality that the workmen themselves are openly heard to confess their preference for the American product, while at the same time the price is 30 per cent. lower than Sheffield prices.

American steel is now being sent into Birmingham in very large quantities, where it is mainly used for bicycle work. For bicycle purposes, for nuts, screws, and bolts, or for anything that can be made in large quantities by means of automatic machinery, the American steel is preferred, not merely by the manufacturer, who finds it lower in price, but generally by the workman, as its uniform temper enables him to work it smoothly with considerably less wear on the tools.

Not only the products, but the American machines themselves, are rapidly being introduced into England, and it is impossible for anyone who is in the habit of visiting the large industrial establishments of England to avoid seeing how rapidly American labour-saving machines are being utilized. Specific instances of this are constantly to be seen,—instances where British manufacturers, who have been fighting all their lives against using American machines, have latterly, through failure to get what they wanted in England, been compelled to adopt foreign-made lathes and other special machines, and now say they would not be without them.

"The business of supplying these American inventions is only just beginning. It is not to the interest of British manufacturers to admit this much, but they are gradually being forced to the conclusion that there is no denying the advance of the American, both in his methods of production, his application of those methods in the use of the machinery by which they are applied, and the men by whom they are worked."

Fighting Floods in India.

THE disastrous consequences which have followed some of the great floods in various parts of India lend interest to a valuable leading article in the *Indian and Eastern Engineer* upon the best methods of fighting floods; although the conditions are in many ways different from those which obtain elsewhere, in the main the remarks apply well to the general subject of the control of rivers in times of excess of water. Rivers may be divided into four great classes: (1) the tidal; (2) the deltaic; (3) the semi-deltaic; and (4) the torrential.

The first class includes great rivers, such as the Indus and the Hooghly, which can hardly be considered rivers at all, but, rather, high sand banks through which the water wanders at will, and over which a bore of unusual size, or a cyclonic wave, spreads unchecked, carrying death, desolation, and ruin in its train. These floods there appears to be no method of preventing, excepting by means of a systematic series of levees, of enormous cost and problematical benefit.

Deltaic rivers are more defined in their courses than are those mainly under the influence of the tides. When the waters are high, the banks are raised by the deposits of silt, and, as the currents slacken, the deposit forms upon the bed. This raising goes on, until, in some unusually high flood, the water finds an easier flow in some old bed, when the course of the whole river may become changed in a few hours for a considerable distance. Attempts have been made to control such streams by the construction of protecting embankments, but, as usually constructed, these are exceedingly dangerous in the long run. The river-bed is continually raised by the deposit of silt, and the embankments require a corresponding increase; and this goes on, until some unusually high flood carries all away, with much more damage than would have been done had the resistance been less. As soon as the flood is over, the embankments are rebuilt, and, the next time they give way, the flood is higher than ever; and so it goes on. It is far better to attempt to lead nature, instead of fighting it, and, instead of confining the channel to a limited bed, which it is sure sooner or later to break down, to permit moderate floods to spread silt and mud over large areas to the advantage of cultivation.

Records of rainfall are of little use in estimating the proper amount of waterway to be provided, as the irregularity of the fall is too great to permit any reliable conclusions to be drawn. At Karachi, for example, nearly twice as much rain fell on one day in 1896 as fell in the whole of 1895, the total fall for 1896 being three times that of 1895. Provision must be made, therefore, for the quantity which may fall in a short time, if safety is to be secured.

The floods, as a rule, do not affect the large bridges, as their foundations are now placed deep enough to resist any scour which can occur. In the case of culverts, however, the wing walls are too short, and they are frequently undermined. This can be avoided, if the wing walls are continued down to the level of the bottom of the stream, with the invert taken as far as their ends, and the drop walls just beyond, in front of them,—a construction which adds much to the cost, but which pays in the end.

Semi-deltaic rivers have fairly stable beds, and the floods are generally confined to them, the overflow seldom being very deep. The difficulty is not with the banks and waterways so much as with the bridges. The channels are generally very wide; either the stream must be contracted, thus inducing corresponding resistance, or else very long bridges must be built. Formerly such bridges were made with shallow foundations and short spans, but these are now rather out of date, being supplanted by long-span bridges with deep piers. It is a question, however, whether the earlier form is not more economical in the long run, if proper precautions are taken to distribute the flow of the stream over the entire width, and prevent abnormal scour at any particular point.

The long-span bridges, with very deep piers, are expensive in the first place, and, in the second, their maintenance is costly, especially when the width of the river is restricted. Not only the piers, but also the abutments, must be very deep and massive, the wing walls having to be carried very far each way in order to prevent the destruction of the banks. The cost of maintenance thus may exceed greatly the amount which would have been required for a longer bridge had the river been permitted to occupy the full width of the valley.

The fourth class, torrential rivers, is a difficult one to deal with, but the method is by no means intricate. Good foundations can always be found at sufficient depth, and the spans must be long enough and the piers high enough to provide for the maximum flood. It is a question of cost and magnitude, but, as the banks are usually well defined and of hard material, they are usually safe, without the reinforcement of protecting walls.

The shallow, widespread overflow-floods which occur in some parts of India can hardly be controlled at all, but serious interruption to travel can be avoided by the construction of low causeways and viaducts, sufficient waterway being provided to keep the causeways from becoming dams and diverting the water to an injurious extent. It was formerly the custom, when a bank had to be carried across a narrow and high ravine, to put an expensive bridge or culvert through the lowest part to provide for the water, but the length and size of such culverts have led to the adoption of other methods. By constructing the lower part of the bank of large stones, sufficient opening is left for the water to pass through, while catch-water drains in the solid earth, carried under the road at each end of the bank, intercept a large portion of the water, and furnish relief to the main portion of the bank.

In all such work local conditions modify the general plans outlined above, and in its construction the lessons of previous experience must be heeded.

The Modern Commercial Gas Engine.

AN interesting paper, read before the North British Association of Gas Managers, by Mr. W. Carmichael Peebles, and published in the *Journal of Gas Lighting*, reviews the development of the gas engine, and the lines along which commercial advance is likely to be made, and contains a number of points of value in connection with improvements in internal-combustion motors.

After reviewing the pioneer work done in France by Beau-de-Rochas, and in Germany by Otto and Langen, Mr. Peebles proceeds to note the advent of the Otto silent gas engine at the Paris Exposition of 1878, and the stationary condition of gas-engine construction during the life of the Otto patents. At the expiry of these patents nearly all manufacturers gave up making their own special types of engines, and adopted the Otto cycle, recognizing in it the only really practical cycle for a simple and efficient gas engine.

The great changes which have taken place in the engine since it was first brought out by Otto are: (1) the method of igniting the charge; (2) the adoption of lift instead of slide valves; (3) the increase of compression.

Though these appear to be simple matters, they have been difficult of accomplishment; yet they have been well worth all they cost. The old method of ignition by means of an open flame, as used in the original Otto and Langen engine, required modification as soon as compression was adopted, as the outflow of compressed gas and air prevented the ignition of the charge within. The flame, therefore, was inclosed in a chamber in the slide. While this served after a fashion, the failures of ignition, especially at high speeds, and the difficulty of lubricating, made improvement desirable.

One substitute for flame ignition is the electric spark. Its use includes an electric battery and induction coil, but in some instances these are not objectionable when the advantages are considered. Corrosion of electrodes, and the extra care involved in looking after the battery, etc., however, render this form of ignition not wholly satisfactory; hence the introduction of the hot tube must be considered a step forward in the evolution of the gas engine. Iron tubes, which were used at first, gave some trouble by choking with deposit, and by becoming brittle, and no metal tube gives entire satisfaction, so far as cleanliness, strength, durability, and igniting effect are concerned. Porcelain tubes, however, which were introduced by Watson in 1881, have proved very satisfactory, especially when, as strongly recommended by Mr. Peebles, a timing valve is used, instead of permitting the ignition to be timed by the compression.

"Compression has been on the increase ever since the adoption of the lift valve. In the early days compression ranged between 25 and 30 pounds per square inch, while now the ranges found are generally between 70 and 90 pounds, depending on the size of the engine."

"This increase of compression has more to do with the economy of the modern gas engine than possibly any other change—firstly, by the reduction in the size of the compression space wherein the burned products may lodge at the end of the exhaust stroke; and, secondly, by the more intimate and closer mixing of the particles of gas and air, thereby insuring a more complete and instantaneous explosion. The highest temperature of the explosion being reached more rapidly, owing to the higher compression, it is not so greatly affected by the cooling action of the cylinder, as the cylinder surface is not much exposed until the piston has moved a little forward; and by that time the bulk of the power contained in the gas has been given to the engine."

A number of improvements have been made in the mechanical details of gas engines, and the modern machine forms a striking contrast in appearance with the earlier engines, with their many cams, springs, gears, and trappy contrivances. Many of these parts have been eliminated in the process of simplification, which generally goes on as the result of practical experience with any complicated machine. The operative portion, however, is still open to much improvement, especially as regards governing and starting, and it is to these features, as well as to increased economy, that the improver of the gas engine should now devote himself.

In concluding, Mr. Peebles says: "There can be no doubt that a great deal has yet to be done to improve the action of the gas engine. The main direction in which a change is to be looked for is, I think, in the cycle. But this would seem almost impossible without introducing complicated mechanism. At present—at least with the smaller sizes—the successful competition of the gas engine with the steam engine is chiefly due to the convenience and economy with which the gas engine can be operated, especially for intermittent work. With engines above 40 or 50 h. p., using producer gas, the cost of working, as compared with steam, is very greatly in favour of the gas engine, as has been proved time after time. We shall find, therefore, that the large gas engines will not stop at 400 or 500 h. p., but increase gradually, year by year, until they compete in power with the largest steam engines made."

Mechanical Features of Naval Personnel.

In discussing the importance of making proper provision for reserves for the royal navy, *Engineering* emphasises some of the salient mechanical features of naval warfare, as brought out in the Spanish-American war; and these are of technical, as well as military, interest.

"On paper there was no great difference between the naval strength of the two powers opposed, but the Americans have practically had a walk-over, because their fleet was better handled and their sailors were more prompt than those of their opponent. This may be said without casting any reflection upon the courage of the Spaniards, for, whatever may be the faults of the nation, we have no reason to suppose that its sailors would not have fought bravely, had weapons been placed in their hands, and had they been trained to the ability to use them."

In England also there is reason to fear that in an emergency many men would be found unfitted for their duties, not so much from neglect and delay of the kind so conspicuous in the case of Spain, as from failure to give sufficient thought to the changed requirements of naval service. The navy has been constantly increased by the addition of ship after ship of the most modern design and equipment, apparently under the impression that they can be manned by sailors not greatly different in training and ability from those in the merchant marine.

Indeed, it is from the merchant marine that the recruits for the naval service are expected to be largely taken, as they have been in the past; but in the past the ready-made sailors received in the merchant service all the training necessary.

"The advance of engineering science has changed all that. The warship is a highly scientific instrument of destruction, and consequently must be handled by highly-specialised experts. On a modern battleship or cruiser, each man must know his work thoroughly, and the appliances of warfare are so numerous and varied, and so interdependent in their use, that failure on the part of one means disablement of many. For reasons such as these it is impossible to depend on the mercantile marine to supply ready-made sailors for the navy in time of need, even if all ships sailing under one flag were manned by subjects of the queen. Still, any sailor possesses the first essential for a sailor,—namely, sea legs, and, perhaps one might add, a sea stomach. At any rate, he can move about a ship without embarrassment,—a thing that needs many months for its acquirement with ordinary humanity. If on this it is necessary to graft some of the special knowledge needed for carrying out duty on board a man-of-war, it is evident we have a moderately useful hand for subordinate positions. The perfect article is, of course, a sailor who is a man-of-war's man solely,—one who has spent all his time for years in learning the complex details of his profession so thoroughly that he carries on duty without an effort, and is not liable to become forgetful under the stress of great excitement. It may be well to point out, however, that war has often to be waged with far from perfect instruments, and, just as an obsolete battleship would be a tower of strength if the more modern creations on both sides were disabled or destroyed, so may a handful of sailors but half trained in military duties be better than any number of absolutely raw hands."

In view of the evident manner in which the increase in the British navy has exceeded the supply of properly-trained men, *Engineering* makes a strong plea for the increase in naval reserves provided for in the present bill. By offering special inducements to ship-owners to take boys into service for training, and by also enrolling these as members of the naval reserve, much may be done to provide for the demand, so that, should the time of need arrive, it may not be found that ships are plenty, but men lacking.

The Railways of Ceylon.

THE railway system of Ceylon affords an excellent example of some of the problems encountered in colonial work. From a paper on the subject in a recent issue of *The Engineer* we take some interesting features, giving also views of the remarkably picturesque scenery at various points.

"When the government took in hand the building of railways in Ceylon, it was not unnatural that they should have adopted the Indian standard gauge of 5 feet 6 inches, for at that time light railways in India had not taken any extension, and there was always an idea—vague, it is true, at the time—that India and Ceylon would eventually become connected by rail across Adam's Bridge."

Thus, although it is now generally admitted that it was a great mistake to adopt the broad gauge for India, there is good reason for the continuance of that gauge in the main line of railway in Ceylon, especially as the connection across the coral reef known as Adam's Bridge has been authorized, and will undoubtedly be constructed.

At the same time there is much narrow-gauge road in southern India, and in Ceylon the conditions are such as to imperatively demand it in many, if not most, of the districts in the interior. The result is the existence of two parties, one advocating only the wide gauge and the other championing the introduction of the narrow gauge.

"The former party is represented by the government officials, to whom cost is a matter of small moment, and the latter by the planters and industrial people generally, whose interests are vitally concerned, and whose pockets bear the bulk of the taxation of the colony."

"The narrow-gauge advocates very naturally resent being heavily taxed for railways of a class which they consider very much too expensive, and in determining the routes of which they have practically no voice, at a time when cheap commercial railways in the proper districts would be of the utmost value to them. Now, however, that the government has sanctioned the 5 feet 6 inch gauge on the connecting line between India and Ceylon, the prospects of the Ceylon residents as to realizing their narrow-gauge dream seem further off than ever, unless the planters themselves are prepared to take the matter up and arrange and build their own lines, as has been done to some extent, and to great advantage, by the big planters in the Dutch East Indies."

At the present time there are, in all, 297¼ miles of main line and 32 miles of sidings in Ceylon, all owned by the government, and all of the 5 foot 6 inch gauge, the highest altitude attained by the railway being 6,230 feet above sea-level. Colombo is the head centre of the system, whence a line runs south to Galle and Mataba, and north-east to Kandy, the capital, and to the principal towns on the plateau, which includes the chief planting district. A sketch map accompanying the article above referred to gives the lines of the proposed railways, including both those which have been authorised and those which are projected, the latter being mostly narrow gauge.

The picturesque character of the country, as shown by some of the illustrations, is not without disadvantages, as the overhanging rock at the Meangalla Galleries, between Colombo and Kandy, was the scene of a disastrous landslip in September, 1897. The location, both before and after the accident, is shown in the photographs, and these and others accompanying them give an excellent idea of the engineering difficulties connected with the construction and operation of the lines.

Fallacies Concerning Boilers.

In nearly every branch of applied science a number of fallacies of long standing have come down from times of imperfect knowledge of the subjects, all of which are extremely difficult to abolish. Probably no one object has been so burdened as the steam boiler, and an editorial in the *Engineer* discusses some of these in an interesting fashion.

One of the fallacies frequently repeated in text-books is that flame will not traverse a tube, and hence that multitubular boilers are wasteful of fuel. This proposition is reinforced by the experiment with a flame and a piece of wire gauze, as in a safety-lamp; because the flame will not readily pass through the gauze, the inference is drawn that it will not pass through the tubes of a boiler. Like many other deceptive statements, this is only partially true; in many cases the flame will not traverse the tubes, and the gas can be ignited at the chimney-top.

"The truth is that whether the flame will or will not pass through a tube depends on the draught. If that is sufficiently strong, the flame can be drawn through a two-inch tube eight or ten feet long, as indeed can be seen at any time by looking through the sight holes provided in the smoke-boxes of certain stationary boilers of the locomotive type. Those who cite the behaviour of the safety-lamp ought to have added that the flame can be very readily made to pass outwards through the gauze by blowing on it; and it is a matter of common knowledge among miners that increased ventilation has been responsible for more than one dreadful explosion, the strong current in the air-way driving the flame through the gauze."

Another prevalent fallacy is that large volumes of carbonic oxide are given off by boilers. The origin of this idea is found in the fact that some of the deep, narrow fireboxes of early locomotives contained so deep a layer of coke that, when the blast ceased upon the stopping of the engine at a station, the furnace became practically a gas-producer, and the carbonic oxide then produced appeared as a stream of blue flame at the chimney. Now, however, such conditions are very unusual, and, when a boiler furnace is in active operation, there is practically no carbonic oxide present.

"Experiments carried out by Mr. Stead and Professor Kennedy years ago showed that under ordinary conditions very little carbonic oxide is produced in marine boilers; and similar tests only go to show that a fireman must take particular pains to obtain carbonic oxide in any quantity."

"Of all boiler fallacies none is more rampant or persistent than the theory that by preventing smoke we can save quantities of fuel. In dealing with this question, we believe it is necessary to assure our readers that we hold smoke to be a nuisance which ought to be abated, or got rid of completely when possible; and that it is worth while to incur cost and loss to get rid of it. But this has really nothing to do with steam-boiler economy. As a rule to which there are very few exceptions, no saving whatever is effected by making a boiler 'consume its own smoke.' It is quite true that economy often results from the use of self-feeding furnaces, or various appliances, patented or unpatented, with which most of us are quite familiar. The improvement is brought about by quite different agencies. Thus, for example, a mechanical stoker which works well will maintain pressure with more regularity than a man. The proper quantity of air can be admitted, and no more; and so on. It was shown many years ago by C. Wye Williams, who was the apostle of smoke-prevention, that the magnificent rolling billows of black smoke poured forth from the funnel of a Holyhead mail steamer owed their colour to a few ounces of finely-divided carbon; that, in a word, a steamer's smoke-trail closely resembles a comet's tail in the insignificance of the quantity of tangible material which it contains. Sir W. Anderson showed far more recently that, so far from a smoky flame being a worse steam generator than a clear flame, it is far better. But the great practical fact is that boilers which are fitted to consume or prevent their own smoke as a rule are not such powerful steam-producers as those which go through life smoking heavily and creating an atrocious nuisance; and the reason is not far to seek. The proper quantity of air required to burn a pound of coal is twelve pounds. But this would only suffice if it were most carefully mixed with the products of combustion as well as supplied to the solid fuel. In practice nothing of the kind is possible. It is, indeed, hoped that something near it may be secured by the use of powdered coal suspended in an air-current as fuel. But that result has not yet been attained. With an admission of but twelve pounds of air per pound of coal, not only would a great deal of smoke be produced, but carbonic oxide as well. With well-managed fires we may get down to eighteen pounds of air per pound of coal, but twenty-four or even twenty-five pounds is by no means an unusual quantity to admit, if the air is taken in over the fuel."

This is fully in accordance with the results attained by the Paris smoke-prevention commission's report, a review of which is given elsewhere in this issue; and there is no doubt that we must consider the prevention of smoke desirable for reasons of cleanliness, comfort, and health, but not for the attainment of economy in fuel.

Other fallacies in connection with the use of steam boilers are discussed in the article above referred to, and the whole paper is a good example of what might be written about many other departments of engineering practice.

Photographing Projectiles.

In the development of instantaneous photography various attempts have been made to secure distinct images of projectiles in their flight, some attempts having been made with success as early as 1887, by Mach & Salcher, at the Imperial Academy of Science of Vienna.

Their photographs revealed some curious phenomena in connection with the formation of air waves, due to the compression in front of the bullet and vacuum behind it, and later photographic work has added to the stock of data upon this subject.

A general review of the action of various media when pierced by bullets is given in *Engineering*, especial attention being given to the nature of the air waves, and many photographs being reproduced. The study has much interest, whether considered from the point of view of the engineer, the physicist, or the soldier.

The air waves, which in most instances are clearly shown in the photographs, resemble in form those made by a boat, the headwave being of hyperbolic form, with succeeding waves originating at the sides of the projectile, especially where there are ridges or grooves in it, while behind there is a sort of cloudy wake, probably a partial rarefaction.

The head-wave is produced only when the velocity of the projectile exceeds that of sound, since otherwise the waves, which travel at the velocity of the propagation of sound themselves, will always remain in advance of the point of the projectile. This head-wave is the report wave which arrives at the same time as the ball; the man at the target hears no whizzing. If the velocity of the bullet is inferior to that of sound, however, then we hear the buzz, and no head-wave appears on the photograph. These views were entirely confirmed during Mach's first experiments on Krupp's gun-trial grounds, near Meppen. It was noticed that sometimes one report, and sometimes two reports, were heard, the second sound being called the echo of the first. Observers within 150 metres of the gun never heard two reports; for those further away the interval depended upon the velocity and the distance from the gun.

Since no shutter could be made to act quickly enough to make the brief exposures necessary for these photographs, and as correct timing would be impossible, the bullet itself is caused to make the exposure by making an electrical contact between two wires, just as it passes the centre of the photographic field, thus closing the circuit of a Leyden jar and producing a bright spark which furnishes the illumination for the photograph. The bullet is thus produced in silhouette, while the air-waves appear because of the variations in the density of the air which they cause.

Among the photographs are some interesting ones taken at the instant of penetration of a card or of a plate of glass, the reflection of the head-wave being vere clearly shown, as well as the shattering of the glass.

These points are of interest to the physicist rather than to the engineer or the military man; but they possess a further interest at present from the bearing which they have upon the peculiar nature of the wounds inflicted by modern firearms. Ever since the introduction of the Chassepot rifle in the Franco-Prussian war of 1870, charges have been made that various high-power rifles were being used with explosive bullets, such statements having been made in connection with wounds caused by Mauser bullets during the Santiago campaign.

There seems to be little doubt, however, that the effects so closely resembling explosions are in reality due to the waves produced in the medium through which the bullet is passing; and experiments made by firing bullets through bodies of horses, as well as through boxes containing wet sand, clay, and other materials, show that solid bullets can produce all the effects supposed to be caused by explosions. The holes produced by these high-velocity bullets in carcasses were surprisingly large; fisssures formed in the bones diverged both forward and backward, and softer parts, like liver, were projected backwards through several yards.

These explosive effects require a minimum bullet velocity of about 240 metres per second, and are most marked at short ranges, though they may be seen in soft parts up to 2,000 metres.

THE CONTINENTAL PRESS

The Status of the Engineer in Russia.

In some countries, notably the United States, the title "engineer" gives little or no information as to the professional standing of an individual, unless to it is added some qualifying statement, such as membership in a recognized engineering society, or position upon some extensive works, either public or private; on the continent, however, the mere title indicates either the possession of a technical diploma, the certificate of a government school, or, possibly, the qualification for government service.

In an interesting communication to the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines* Herr von Abramson gives the conditions surrounding the status of the engineer and architect in Russia.

In the first place, no one in Russia may use the title "engineer" or "architect" with his name, unless he possesses a government diploma, which latter can be granted only by certain designated technical high schools. This diploma confers also upon the recipient the power to superintend, with full responsibility, construction work anywhere within the limits of the empire, and places him in the tenth rank of the government service, corresponding to that of lieutenant in the army, this being indicated by a special badge worn upon the right breast. Any one not possessing such a diploma, who nevertheless may be a skilled practitioner, or may possess a diploma from some foreign institution, may indicate his profession by the title "techniker," and, in order to have the privilege of assuming sole responsible charge of constructive work in the empire, such an individual must pass an examination before a government board, although this does not permit him to call himself either engineer or architect.

If a practical or technical man, educated in some other country and probably fully qualified by attainments, desires to obtain the title "engineer" or "architect," with all that these imply in Russia, he must enter one of the designated State high-schools, as a native student would. This not only involves the passing of a five years' course of study, but also necessitates the brilliant passing of a severe entrance examination, based especially upon a full proficiency in mathematics and in the Russian language. The term "brilliant" is used advisedly, since the number of applicants far exceeds the available vacancies, and hence only the ablest are accepted.

When the applicant has already received a Russian diploma in some allied branch of applied science, and desires the diploma of engineer or architect, he is permitted to enter the technical high-school without the preliminary examination, and obliged only to pass the annual or semi-annual examinations, the course being abridged to two or three years, according to the rank of the school. This rule also applies to foreigners possessing diplomas from recognized technical institutions of their own countries.

In Russia, in many instances, military engineers are permitted to engage in civil work, mainly in special lines pertaining to government structures and to railway construction, and many army engineers have attained high rank in railway engineering. When a military engineer is engaged in constructive work for structures pertaining directly to the government service, he remains in the active service, and is eligible to promotion in regular order; but, when he enters purely civil work, such as railway engineering, he is passed to the reserve, and is promoted only for cause, based upon exhibition of marked ability. Military engineers engaged in civil work, however, are liable to be called into active service at any time, by order of the minister of war.

Herr Abramson's paper contains much interesting information concerning the special technical schools authorized to confer engineering and architectural diplomas, showing the nature of the courses and the high character of the instruction. These institutions vary according to the special line of instruction, including civil and mining engineering and architecture, as well as the branches of a general liberal education necessary for an intelligent practice of the profession.

In consequence of this strict regulation of engineering education and control of the privileges of practice in Russia, the professional status of the engineer and architect is clearly defined, and an *esprit du corps* maintained which otherwise would hardly be possible. While there may be some loss to the science of engineering from the absence of foreign engineers, due to the strict requirements for admission to the privilege of practice in the empire, yet, as a whole, the cause of Russian engineering is well served by the native profession, and the progress which has been and is being made shows that ideas from abroad promptly find their way into active use.

Smoke-Prevention in Paris.

In Paris, as in other cities, the growth of the smoke nuisance has produced numerous calls for legislation looking to its abatement, and, before proceeding to legislation which might prove either ineffective or oppressive, the municipal authorities decided to appoint a technical commission to investigate the entire subject.

This commission has been in active operation since 1894, and, having practically concluded its labor, is making the results public, these being given in abstract in recent issues of *Le Genie Civil*, and as a full report, serially in the *Revue de Mecanique*.

In order to be fully informed as to the best smoke-preventing devices available, the commission decided to institute a series of tests, offering prizes to the furnaces giving the best results; and the report includes descriptions of the various devices submitted, with a critical account of their performance.

One hundred and ten different forms of smoke-preventing apparatus were entered for competition, classified as follows:

1. Mechanical stoking and uniform combustion	16
2. Supplementary injection of hot or cold air	20
3. Injection of steam, with or without addition of air	5
4. Mingling of flames and combustion of smoke	7
5. Gas producers and gas firing	7
6. Pulverizing the fuel previous to combustion	2
7. Washing of the discharge gases	16
8. Miscellaneous systems	37
	110

The various devices were successively erected under the same boiler,—one of the so-called "elephant" type, with two heaters below, this being the style commonly used in France,—and the same fuel was used in all the tests. This fuel was the Anzin briquette, of the ordinary quality, containing an average of 8.17 per cent. of ash, and 17.84 per cent. of volatile matter. Each device was subjected to two kinds of tests, one with slow firing and the other with the firing forced to supply the engines fed by the boiler to their full capacity. Each test was made twice, the first time with a stoker selected by the maker of the device, and the second with the stoker employed by the commission, thus eliminating as much as possible the personal equation or individual elements. The tests included the determination of the quantity of fuel burned per unit of grate area, and the evaporation per unit of area of heating surface and per unit of weight of fuel, as well as the measurement of the relative amount of smoke produced.

The measurement of the amount of smoke produced by each device was accomplished by an ingenious method, which, while probably hardly entitled to be considered as a method of precision, was still reasonably correct, and doubtless fair to all the devices tested.

A smoke scale of five degrees of intensity, ranging from complete absence to complete opacity, was decided upon, and the amount produced was recorded upon a cylinder revolved by clockwork, by means of a pencil which could be pressed into contact with the paper by hand. The observer watching the chimney top pressed the pencil against the paper during any period when smoke was produced, the paper being divided into five portions corresponding to the five grades of smoke. The ordinates thus represented time, and the abscissas represented smoke. The area enclosed was measured by a planimeter, and this area was taken as a measure of the smoke production of the particular furnace under consideration.

Of the many devices submitted to these tests, three general types gave results which appeared to be reasonably satisfactory. Two prizes of 5,000 francs each were awarded to the Donnelly furnace and the Proctor mechanical stoker, while a prize of 2,000 francs was given to the Hawley down-draft furnace. In addition to these, honorable mention was given to the furnaces of MM. Dulac, Hinstin, and Orvis, the awards in all cases being based upon the results of the measurement of the diagrams produced by the smoke-recorder.

The Donnelly is a coking furnace and the Proctor a mechanical stoker, while the remaining furnaces endeavor to insure complete combustion by thorough intermingling of the gases with a suitable amount of air, the Orvis using, in addition to the natural draft of the chimney, the force of a steam jet.

Without going too fully into the details of the tabulated results, for which the reader is referred to the articles above mentioned, the conclusions of the commission may be given, as applying generally to the smoke problem, both in Paris and elsewhere.

In the first place, the experiments made before any of the special devices were tried showed that the ordinary grate is unsuited for smokeless production, and that, even with the most careful stoking, the common grate will permit the formation of smoke.

In the second place, it was clearly demonstrated that smoke-prevention and economy do not necessarily go together. The blackest of smoke represents an insignificant amount of fuel, and the tests demonstrated that the devices which produced the least smoke were not the most economical. It should, therefore, always be assumed that the prevention of smoke involves expense, proper allowance being made therefor.

Smoke may always be prevented by using coke, but, as this is, in many cases, unavailable, the only remedy lies in the use of such devices as will produce a minimum of smoke, the true principle being, not the combustion of the smoke, but the absence of its production.

The commission recommended the prohibition of thick black smoke, as the trials showed that many devices would accomplish this result. It was also recommended that those devices which showed the best results during the tests be placed in manufacturing establishments with a view of establishing their durability and effectiveness in regular service, and, above all, that the existing regulations be thoroughly enforced by patient and competent officials.

The Correction of the Rhine at St. Gall.

AMONG the important river-improvement works recently completed in Europe, the correction and regulation of the upper Rhine, at its entrance into the lake of Constance, is well worthy of notice, and a paper in the *Schweizerische Bauzeitung*, by Herr J. Wey, the chief engineer of the undertaking, gives a condensed account of the nature and extent of the work.

For a long time the irregular action of the river upon the lands of St. Gall and the Vorarlberg has been a source of much trouble, the sinuous nature of the stream and the low banks lending themselves readily to the production of destructive floods in time of high water, so that the surrounding territory was frequently overflowed, much damage being done.

Instead of endeavoring to protect the banks by the construction of embankments upon both sides, following the path of the old channel, it was determined to construct two entirely new sections, forming cut-offs which would straighten the stream, and also enable the surrounding country to be protected both by the embankments and by the relief to the water afforded by the more direct outlet to the lake. The second, or Fussacher, cut-off forms an entirely new mouth of the river at its entrance to the lake of Constance, the old mouth, with its delta, being left more than five miles to the left of the new bed. The first, or Diepoldsauer cut-off, straightens the stream so that the old channel is left nearly a mile and a half to the right, the two new channels shortening the river nearly six miles and a half.

One of the most interesting engineering feats in connection with the work was the construction and operation of the dredge by which the cut-outs were excavated and the embankments constructed. This apparatus consisted of two separate iron hulls. The first was 22 meters long by 7 meters beam and 2.6 meters deep, and carried the bucket dredging apparatus, which was operated by a compound engine, the buckets containing about 110 liters each. These buckets deposited their charge upon a grating of 10 to 12 millimeters' spacing, this being sufficient to retain the coarser gravel and pieces of stone, while the sand, earth, and finer gravel passed through. A powerful centrifugal pump, driven by a direct connected engine making from 600 to 700 revolutions per minute, directed a stream of water upon the mass, washing the finer material through the grating to a reservoir in the second boat, from which the fluid mass was discharged by means of two centrifugal pumps, which delivered through rubber tubing supported upon traveling carriages. The coarser material, which could not pass the grating, was delivered upon rubber-conveying belts, which, supported upon a cantilever framework, delivered the stuff to the banks on either side, to assist in forming the enbankments.

The second boat, which was 16 meters long, 6 meters beam, and 2.6 meters deep, contained the centrifugal pumps, with their motive power, as well as the tower which formed the central portion of the cantilever carrying the conveying belts. The whole formed a very effective apparatus, and proved of even greater capacity than its rating of 75 cubic meters per hour.

In addition to the construction of the new cuttings, the regulation work involved the canalization of that portion of the old channel which was retained, the embankments protecting the banks and enabling the flow to be controlled within reasonable limits, even in times of high water.

The entire work has been completed, after six years of active operations, at a total cost of more than 23,000,000 francs.

The Elasticity and Strength of Materials

MUCH attention is constantly being given in various technical journals to the questions involved in the resistance of materials of construction to deformation, and the study of the nature of the internal stresses induced by external forces is a feature which has developed as our knowledge of the structure of the materials themselves has advanced.

In recent issues of the *Zeitschrift des Vereines deutscher Ingenieure* there have been several important papers bearing upon this subject, and, although the nature of the investigations and the necessary use of mathematical expressions prevent a full review in these columns, some general idea of the treatment can be given.

Among these papers is one by Dr. Kirsch, of Chemnitz, upon the theory of elasticity in relation to the resistance of materials. Taking as the starting-point the fundamental principle that in an elastic body the extension is directly proportional to the load, he considers the material as composed of successive very thin layers, all parts of each layer being equally distant from a neutral axis or surface, and proceeds to show the unequal deformation in various portions of a body, owing to the unequal distribution of the forces. By plotting the lines of equal extension in any given section, he shows some very interesting diagrams, which give a much clearer idea of the nature of the internal strains than could otherwise be had. In some instances it is shown how a reduction in cross-section is accompanied with an actual increase in strength, these theoretical conclusions being fully sustained by actual tests.

A second paper in the same publication, by Herr W. Schule, of Hagen, discusses especially the law of alteration in length of prismatic bodies when subjected to forces producing extension or compression. In this paper many diagrams are given, showing how closely the theoretical curves agree with those obtained by plotting the observations made upon so different materials as granite, rubber, steel, silver, and copper, the data being taken from the experiments of Bach, Winkler, and J. O. Thompson.

A third paper, by Dr. Holzmüller, takes into account especially the conditions existing in thick cylinders, subjected to internal pressure. In order that the reader may obtain a clear idea, he commences by assuming a plate of metal in which a round hole is bored, and considering the conditions which would exist if a steel pin somewhat too large for the hole were driven in.

The plate is supposed at first to be of unlimited area, in which case the radial and tangential stresses are equal to each other, and inversely proportional to the square of the distance from the centre. Taking this as a starting-point, various limiting forms are given to the metal about the hole, and the corresponding distribution of stresses and strains is considered. With these also is considered the case in which two holes are pierced in the plate, and equal distending forces are assumed to be acting in each of them.

The transition from the diagrams constructed upon the assumed plates to the forces in the interior of the metal of a thick-walled cylinder is readily made, and the nature of the problem is much simplified by this method of treatment. In many instances the lines of the forces drawn in accordance with the elastic theory resemble so closely the magnetic lines of force produced by the action of magnetic poles upon surfaces covered with iron filings that the similarity in the actions and conditions is brought to mind.

In all of the papers mentioned a certain amount of mathematical treatment is involved, but in none of them is this sufficient to deter the general reader from gaining much valuable information, and all form important contributions to the study of the strength of materials.

Space Telegraphy at Sea.

In the last issue we spoke of the desirability of providing some more reliable indicator of the presence of an approaching vessel than any based upon sound, and referred to the possible use of the thermopile for this purpose.

A note presented to the French Academy by M. Branly in connection with a suggestion of MM. Berget and Décombe, and given in *Comptes Rendus,* calls attention to the possibilities of the use of the coherer as an indicator of the approach of a vessel, either at night or during fog.

The method proposed by M. Branly is the very simple one of providing all vessels with at least one transmitter and with several receivers or coherers. Periodical signals being made with the transmitter, corresponding impressions would be made upon the receivers of vessels in season to serve as warning against collision.

The principal difficulty which appears in connection with this idea is the fact that the receivers on any vessel would be affected by the transmitter on the same ship; but there are several methods by which this difficulty may be overcome. The obvious method of using different signals might be employed, or the interval between signals might be chosen to observe the receivers for impressions from approaching ships.

M. Branly, however, calls attention to an observation also communicated by him to the Academy a short time ago, as to the influence of a metallic envelope surrounding a coherer, and shows that, when the coherer is thus completely surrounded, it is unaffected by the influence of a transmitter. By thus enclosing the receivers on a ship only at the instant of the operation of the transmitter of the same vessel, protection against the influence of the transmitter would be secured, while at the preceding and succeeding moments the coherers would indicate at once the presence of a transmitter on an approaching vessel.

Entire protection against the influence of a neighboring transmitter is attained when the metallic envelope is completely closed, but, by providing a small slit, of adjustable size, various degrees of sensibility may be obtained, and in this manner some estimate of the distance of the influencing transmitter may be made. If the receiver be placed upon an axis and turned, the position of the slit at the moment of strongest influence also furnishes an indication of the direction of the transmitter, and the increasing or diminishing action shows whether the vessel is approaching or receding.

While there seems to be little doubt of the efficacy of this mode of prevention of collisions at sea, it can hardly be considered available unless introduced upon the vessels of all countries. This difficulty also existed in the case of the present fog-horns and sirens, however, and, should it be demonstrated that the methods of space-telegraphy can be used with any degree of certainty for the prevention of such disasters as the loss of the Bourgogne, no price within reach would be too high to pay.

The Conservatoire des Arts et Metiers.

THE celebration of the centennial anniversary of the foundation of the great museum of mechanical and technical models which is contained in the buildings of the former priory of Saint Martin-des-Champs at Paris, and now known as the Conservatoire des Arts et Métiers, is the occasion of the publication in *Le Génie Civil* of an interesting article about the museum and its contents.

The idea of founding a mechanical museum is due to Descartes, but it was not until nearly one hundred and fifty years after his death that the present museum was established, and on 22 Prairial in the year VI according to the republican calendar (June 10, 1798), the National Convention set apart the secularized priory for the purpose.

The nucleus of the incomparable collection now in existence was found in the collections of the two celebrated inventors of the seventeenth century, d'Ons-en-Bray and Vaucanson. Of the two men but little can be said except as to their mechanical ingenuity, the former being a Hollander who, although an amateur, was a most ingenious inventor, while the latter was best known through his very clever automatons. Both left collections of models of much historical interest and value, and these, together with the laboratory apparatus of Lavoisier, the cabinet of Buffon, and the physical apparatus of Charles, fell into the hands of the Convention at the time of the Revolution, and fortunately were preserved as the beginning of the new museum.

Since its foundation the museum has been the recipient of many important and valuable gifts. The minister of public works, for example, has permitted to be deposited there all the fine models of the Ecole des Ponts et Chaussées, including bridges, viaducts, dams, locks, etc. The great works at Creusot has had made, especially for the conservatory, a series of models of the most important of its products, this collection being sufficiently important to have a hall by itself, bearing the name of the donor. Many other additions have been made, and any one who to-day visits the museum finds a wealth of mechanical construction in miniature such as can be found nowhere else in the world.

In connection with the collection of models, the museum has also done excellent work in the department of mechanical instruction, and, as long ago as 1816, courses in applied science were instituted, these being free to the public, and in the hands of eminent scientific men of the day. The original series included only mechanics, chemistry, and industrial economics, but to these were added, in 1836–1839, courses in applied mechanics, descriptive geometry, industrial legislation, applied chemistry, and agriculture. These were followed at later dates by courses in ceramics, civil construction, textile industry, electricity, metallurgy, etc., until at present there are seventeen distinct courses of study open to the public.

There is not space to discuss the character of the courses thus offered, but the names of some of the eminent men who have acted as instructors will give an idea of the nature of the work done. Among the professors may be found the names of Pouillet, Becquerel, Plante, Peligot, Payen, Boussingault, and Tresca, while among those who have carried on invaluable researches in the laboratories of the museum may be named Leverrier, Violle, and Marcel Deprez.

Not the least interesting feature of the museum is the character of the buildings in which the collection is housed. The library is placed in the former refectory of the priory, and the collection of more than 40,000 volumes forms a valuable reference library, being especially rich in scientific works and in collections of drawings, designs, and diagrams. Among the manuscripts of the library are included a number of mechanical diagrams by Vaucanson, and the autograph letter of Fulton offering his steamboat designs to the French government.

Probably the most remarkable room in the entire museum is the machinery hall,—the former church of the priory. This structure, which is a remarkably fine example of French Gothic architecture, built in the eleventh and twelfth centuries, and attributed to Pierre de Montereau, the architect of the Sainte Chapelle, is now entirely filled with modern machinery in motion, the collection including dynamos, motors, electric lamps, acetylene generators, and machine tools of all sorts. The contrast between the mediæval architecture and the modern machinery is most striking.

In view of the good work which the museum has performed during the first century of its existence, a constantly-increasing influence may be anticipated for the future, and every engineer and mechanic who has had the privilege of visiting this great collection of the products of mechanical science goes away with the feeling that similar museums should form a portion of the educational work in every country.

Tests of Masonry Staircases.

THE Society of Austrian Engineers and Architects has done much to advance the cause of constructive masonry by its carefully-conducted tests upon full-size structures. The tests of masonry arches made several years ago formed the most valuable contributions to that branch of engineering which had been made, and the tests of masonry staircases, a partial report of which appears in the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines*, furnish another example of painstaking research.

The tests were made upon flights of nine steps of dressed sandstone, the upper and lower steps being solidly supported, and the intermediate ones transmitting the forces acting upon them to the upper and lower steps, which acted as abutments. An inclined framework, placed beneath the whole, enabled the deflections to be measured under any given loading, and from the measurements diagrams of the deformations have been constructed.

The tests included the various conditions which may obtain in actual practice, and measurements were made with one or two steps in various parts of the flight loaded, as well as with the full load upon the whole structure. In all cases the loads consisted of piles of pig iron carefully piled upon the steps in such a manner as to insure the desired distribution, and, the correct weight of each pig being known, there was no question as to the actual loads in any case.

In addition to the uniformly-distributed loads placed upon the various portions of the staircase, tests were made of the capacity of the various stones to resist torsion, these tests being made with a lever device which enabled any desired turning moment to be exerted upon one end of a single step, without producing an accompanying bending.

The results, so far as given, are included in tables and diagrams too voluminous to be reproduced here, but readily available for use and reference in the original publication.

The principal difficulty in the use of these tests as they stand lies in the uncertainty as to the exact equivalent, in other countries, of the especial varieties of stone included in the trials. Apart from this question, which is not of as much importance as it seems to be, the information as to the distribution of pressure and the nature of deflection is very general in its nature, and forms an important contribution to the common stock of knowledge in building construction. So far as the actual strength of the material is concerned, that should be determined by local tests in any case, as the differences between various pieces of the same kind of material are often as great as those found between pieces of different kinds. With a knowledge of the general character of the problem and the possession of a few tests of the immediate material in hand, the constructor can proceed with a fair degree of assurance of the security and stability of his structure.

Telegraphing with Light and Electricity.

ONE of the principal difficulties encountered with the magnetic wave system of space telegraphy, as developed by Lodge, Branly, and Marconi, lies in the fact that the waves are propagated equally in all directions. Attempts have been made to collect and concentrate them by means of concave mirrors and similar devices, but without practical success; hence the electro-magnetic method must be considered to be as yet in the experimental stage.

A new method is now proposed, and discussed at length, in a paper by Herr Karl Zickler in the *Elektrotechnische Zeitschrift*, in which a principle discovered by Hertz in 1887 as to the influence of certain short-wave-length light rays upon electrical discharges is utilized. The most effective rays for this purpose are the ultra-violet, and, as these are transmitted by quartz and obstructed by glass, this fact is utilized in connection with the method of transmission.

The source of light in the transmitter is an arc lamp, the rays from which are reflected and collected by a lens of rock crystal and projected upon the receiver. The latter consists of a glass vessel, closed air-tight at the end by a truly parallel plate of rock crystal, and partially exhausted of air. In front of the receiver is placed a rock crystal condensing lens, and within the exhausted chamber are the two electrodes, one of which is an inclined disc and the other a small ball. These electrodes are connected with the secondary portion of an induction coil, and, when the ultra-violet rays fall upon the inclined disc and are reflected to the ball, a discharge will be produced, which may be used either with a telephone, or a coherer to be read.

The signals are sent by alternately interposing a plate of glass in front of the rays issuing from the transmitter, and removing it therefrom, the interruptions corresponding to the make and break of a telegraph key.

Since the glass does not produce any variation in the visual effect of the rays, the signals cannot be read by sight; hence such an apparatus, in the form of a searchlight, might be used to communicate from one ship to another, without revealing the fact to onlookers.

Herr Zickler has made many experiments to verify his conclusions, and appears to have demonstrated the feasibility of his idea in practice.

He is now making the arrangments necessary to carry on further experiments at greater distances than were at first attempted. The early trials were made with a distance of only 50 metres between the transmitter and receiver. It is claimed that, while the distance to which messages may be sent by this system is limited mainly by the strength of the light, it is also dependent to a certain extent upon the nature of the light, the strength of the current, and other conditions.

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American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
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Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
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Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
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Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
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Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
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Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
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Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs. and Surveyors. Peoria, Ill.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienn
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécanique. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scientific Machinist. *s-m.* Cleveland, Ohio.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Asylum.

West Bangour New Lunatic Asylum. Describes a new asylum designed by Hyppolyte J. Blanc, the result of much study and travel, with the aim of making the building as perfect as possible. 1500 w. Arch, Lond—Aug. 12, 1898. No. 22180 A.

Capitals.

Some Capitals in Lincolnshire Bell Towers. An interesting illustrated description of pre-conquest work of various types. 1700 w. Builder—Aug. 6, 1898. No. 22052 A.

Composition.

Principles of Architectural Composition. John Beverley Robinson. General discussion of the subject to aid students. Considers the involved nature of architectural design, the qualities of unity and grace. Ill. 3000 w. Arch Rec—July-Sept., 1898. No. 21893 C.

Concrete Construction.

Constructing a Large Monolithic Concrete Building. Illustrates and describes methods and plant employed on a 200x250-ft. building of concrete reinforced by iron rods. 3800 w. Eng Rec—Aug. 20, 1898. No. 22194.

A Large Monolithic Factory Building. Illustrated description of a 200x250 feet, 4-story building for a quarter of its area, and 1-story elsewhere, built entirely of concrete in which steel rods are bedded. 2500 w. Eng Rec—July 30, 1898. No. 21811.

Courthouse.

The Construction of Courthouse Buildings. (Ueber den Bau von Gerichtsgebäuden.) A. von Wielemans. With especial reference to public buildings in Austria, including plans of the court houses at Graz and at Olmutz. 5000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—July 15, 1898. No. 22318 B.

Domestic Architecture.

An Architectural Experiment. R. A. C. Illustrates and describes an attempt to adapt Japanese architecture to the climatic and other conditions of a Massachusetts home, that the house might be in keeping with its oriental furnishings. 2000 w. Arch Rec—July-Sept., 1898. No. 21895 C.

English Habitations. A review of the progress of architecture in England from earliest times to the reign of Charles I. 4000 w. Arch, Lond—Aug. 12, 1898. No. 22181 A.

Fireproofing.

Fire-proof Buildings. Francis C. Moore. Extracted from the publications of the British Fire Prevention Committee. Discusses the precautions that should be taken in the construction of these buildings, and the dangers that threaten. 2600 w. Can Eng—Aug., 1898. Serial. 1st part. No. 21996.

Progress in the Application of Fireproofing to Structural Iron Work. (Die Fortschritte in der Anwendung und Erfahrungen über die Feuersicherheit des Eisens im Hochbau.) W. Linse. An examination into the value of various fireproofing materials, showing apparatus for testing the strength of iron columns when covered and subjected to heat. Serial. 1st part. 3500 w. Stahl und Eisen—Aug. 1, 1898. No. 22357 D.

Security Against Fire. A paper entitled "Lessons from Fire and Panic," read by Thomas Blashill before the Surveyors' Inst., and published by the British Fire Prevention Committee. Calls attention to details often neglected, which are essential for the protection, and the construction of fire-resisting buildings. 3000 w. Arch, Lond—Aug. 12, 1898. No. 22182 A.

Foundations.

Caisson Foundations. Illustrated description. 1500 w. Eng Rec—July 30, 1898. Serial. 1st part. No. 21812.

House Planning.

Common-Sense Planning. Russell Sturgis. Suggestions on planning houses, studying exterior and interior effect, and discussing some arrangements given as illustrations. 4800 w. Arch Rev—Vol. V, No. V—1898. No. 21900 F.

Ice Houses.

Construction of Small Ice Houses. Recommendations from the report of committee appointed by the Assn. of Ry. Supts. of Bridges and Buildings of the United States. 1000 w. Ice & Refrig—Aug., 1898. No. 21829 C.

Jubilee.

The Jubilee Exposition of 1898 in Vienna. (Jubiläums-Ausstellung 1898 in Wien.) Description and illustration of the handsome pavilion of the City of Vienna, erected in honor of the Imperial Jubilee. 1200 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Aug., 1898. No. 22369 D.

Libraries.

New Ideas in Library Buildings. William E. Foster. Extract. Considers some details of the architecture and arrangement of libraries. 1800 w. Am Arch—July 30, 1898. No. 21871.

Milan.

Milan Cathedral. Introductory remarks on the many architectural works of interest in the city, with account of the magnificent Gothic structure—the Cathedral dedicated to St. Mary. 1600 w. Am Arch—Aug. 6, 1898. No. 22002.

Modern Architecture.

Good Things in Modern Architecture. Russell Sturgis. Illustrated description of recent work with critical comment. 5800 w. Arch Rec—July-Sept., 1898. No. 21896 C.

Ornament.

A Study of Evolution, Persistence, and Reversion in Ornament Motives. A. D. F. Hamlin. An interesting study of the origin and development of decorative designs. Ill. 5500 w. Arch Rec—July-Sept., 1898. No. 21894 C.

St. Martin's.

St. Martin's, Canterbury. Review of a work by Rev. C. F. Routledge, giving something of its history and construction. 2800 w. Builder—July 30, 1898. No. 22007 A.

Staircases.

Report Upon the Thrust of Staircases. (Bericht des Stiegenstufen Ausschusses.) Prof. J. E. Brik. An illustrated report of the tests made by the Austrian Society of Engineers upon the behavior of a flight of masonry steps under various conditions of loading and material. A valuable paper. Two articles. 9000 w. Zeitschr d Oesterr Ing u Arch Ver—August 5, 12, 1898. No. 22323 each B.

Steel-Cage Building.

The De Dino Building, New York City. Illustrated description of steel-cage and steel-grillage work in a 13-story office building. 500 w. Eng Rec—Aug. 15, 1898. No. 22095.

Suburban Home.

Suburban Residence Built of Brick. Charles A. Rich. An interesting illustrated description of a very artistic home. 2000 w. Br Build—Aug., 1898. No. 22229 C.

Underpinning.

Underpinning of St. Mary Woolnoth. Illustrations showing interesting engineering work being carried on in London, made necessary by the extension of the City and South London Ry., underground. The Lombard-street station will be situated under this church. 1600 w. Engng—July 29, 1898. No. 21960 A.

Workmen's Homes.

The Housing of the Working Classes Act (1890) in Edinburgh. William Bruce. An account of improvements made and projected for the benefit of the laboring class. 2200 w. San Rec—July 22, 1898. No. 21823 A.

Workmen's Dwellings in Belfast. James Munce. Interesting notes on the improved dwellings, almost every family occupying one house. Ill. 2800 w. Jour of San Inst—April, 1898. No. 21858 G.

HEATING AND VENTILATION.

Cold Storage.

Cold Storage. Comments on Prof. Rane's experiments, giving extracts from his paper read before the Philadelphia Society for the Promotion of Agriculture. 1000 w. Ice & Refrig—Aug., 1898. No. 21828 C.

Fans.

Fans and Blowers. J. H. Kinealy. On the theory of the action of the ordinary centrifugal type of fan or blower. 1000 w. Heat & Ven—Aug. 15, 1898. No. 22206.

Some Experiments Upon Ventilating Fans. W. G. Walker. Abstract of a paper recently read before the British Inst. of Mech. Engs., giving an account of late experiments and their results. 1600 w. Eng Rec—Aug. 6, 1898. No. 21990.

Germs.

Making Human Abodes Germproof. Frederick Baumann. Suggestions for the protection of foundations, and sewer and water pipes. 1400 w. Dom Engng—Aug., 1898. No. 22100 C.

Hospital.

Ventilating and Heating a New York Hospital. Illustrated description of an interesting application of the indirect hot-blast system in the Hospital for the Ruptured and Crippled. The ventilation is effected by the use of exhaust fans placed on the roof. 1300 w. Eng Rec—Aug. 6, 1898. No. 21991.

Hot-Water.

Hot-Water Heating in a New York Residence. Illustrated description of a plant with an unusual amount of indirect heating installed under difficult conditions. 1300 w. Eng Rec—Aug. 20, 1898. No. 22195.

Schools.

Heating and Ventilating Apparatus for Public School Building No. 122, Northeast Corner First Ave. and Ninth St., New York City. Illustrated detailed description. 8500 w. Heat & Ven—Aug. 15, 1898. No. 22205.

Heating the Eastern Illinois State Normal School. Illustrated description of a building heated and ventilated by what is known as the double type of the plenum system. 1000 w. Met Work—Aug. 13, 1898. No. 22043.

Steam Heating.

A Plan for Increasing the Capacity of the Steam Heating Plant of the Spooner Library, University of Kansas. Frank E. Ward. Showing how a difficulty in forcing the steam over to the library from the boiler-house was overcome. Ill. 900 w. Kansas Univ Quar—July, 1898. No. 22215 D.

Ventilation Tests.

Some Accepted Tests on Ventilation—Are They Reliable? T. C. Northcott. Discusses the shortcomings of tests in use, though recommending their use until less defective methods can be substituted. 1800 w. Dom Engng—Aug., 1898. No. 22103 C.

PLUMBING AND GASFITTING.

Court Decision.

The Municipal Plumbing Business of Waycross. Review of a decision of the Georgia Supreme Court prohibiting plumbing by city officials. 700 w. Eng Rec—July 30, 1898. No. 21807.

Drainage.

Drain Testing. J. Spottiswoode Cameron. Some facts revealed by testing the drains of 1121 houses in which typhoid and diphtheritic disease was thought to be present. 1500 w. Jour of San Inst—April, 1898. No. 21859 G.

Error in Drainage Practice. W. M. Watson. Showing the evils of using too many drain traps and using drains of too large size. 1000 w. Can Eng—Aug., 1898. No. 21994.

Education.

Science and Plumbers' Work. P. Phillips

Bedson. From a lecture delivered before the North of England Dist. Council, Nat. Registration of Plumbers. Brief suggestion for the education of plumbers, and the need of some knowledge of the sciences to understand the problems to be worked out. 1500 w. San Plumb—Aug. 1, 1898. No. 21881.

Hotel.

An Extensive Plumbing Job. Account of the plumbing and heating of the Hotel Sterling at Wilkes Barre, Pa. 350 w. Metal Work—Aug. 27, 1898. No. 22254.

Lead Work.

A Notable Piece of Lead Tank Work. An illustrated account of the lining of the immense tanks in Madison Sq. Garden, New York, arranged for the presentation of imitation battles for public entertainment. 700 w. Met Work—Aug. 13, 1898. No. 22044.

Plumbing Details.

Some Plumbing Details in Columbia University Gymnasium. Part first gives an illustrated general description of the work. 1000 w. Eng Rec—Aug. 27, 1898. Serial. 1st part. No. 22278.

Sanitation.

Relation of Plumbing to Health. Albert E. Hyde. The important part plumbing bears to the prevention of disease is shown. 1600 w. Dom Engng—Aug., 1898. Serial. 1st part. No. 22102 C.

Trade Schools.

The Proficiency of the Trade School Plumber. An account of one test applied to the students in their final examination. Ill. 700 w. Met Work—Aug. 27, 1898. No. 22253.

MISCELLANY.

Architects' Charges.

The Schedules of Charges of British and German Architects. Gives schedules adopted by the Royal Institute of British Architects and the German Society of Architects and Engineers. 2000 w. Eng Rec—Sept. 3, 1898. No. 22536.

Architects' Responsibilities.

Architects' Legal Responsibilities. Review of decision of Michigan Supreme Court on an architect's responsibility for unsatisfactory details. 800 w. Eng Rec—Aug. 27, 1898. No. 22268.

Brisbane.

Brisbane. Some interesting information of the architecture of this capital city of Queensland, Australia. Ill. 2300 w. Builder—Aug. 20, 1898. No. 22415 A.

Ceilings.

Something About Ceilings. From L. A. Shuffrey's paper on "House Decoration." Discusses how to prevent cracking of the plaster, finishing, treatment of old ceilings, ornament, &c. 1000 w. Plumb & Dec—Aug. 1, 1898. No. 22042 A.

Decoration.

The Use of Smoothing Materials and the Decoration of Highly Finished Surfaces. Walter J. Pearce. Suggestions for the finishing of painted surfaces. Ill. 2000 w. Plumb & Dec—Aug. 1, 1898. No. 22041 A.

Dundee.

The Architecture of Our Large Provincial Towns—Dundee. Illustrates and describes the architecture, gives brief history of the place, and remarks its recent growth. 9500 w. Builder—Aug. 13, 1898. No. 22169 A.

Earthquake Districts.

Buildings in Earthquake Districts. Note on the proceedings of a committee to inquire into the question of the most suitable types of buildings in districts liable to earthquakes. 1800 w. Ind Engng—July 28, 1898. No. 22221 D.

Educational.

The Columbia University School of Architecture. William R. Ware. An explanation of the work being done for professional draughtsmen. 2500 w. Am Arch—Aug. 6, 1898. No. 22001.

Estimating.

Estimating Brickwork. F. E. Kidder. Explains the system adopted by the Brick Contractors' Exchange of Denver, and illustrates its application. 1200 w. Br Build—Aug., 1898. Serial. 1st part. No. 22231 C.

Floors.

Hardwood Floors. Edgar J. Spratling. Suggestions for the selection of flooring, and the laying, finishing and care. 1500 w. Am Arch—Aug. 20, 1898. No. 22184.

Fresco.

Leon Batista Alberti on Fresco. Concerning the coats of plaster, how the mortar is to be prepared, statues, bas-relief and pictures for adornment. 1800 w. Arch, Lond—Aug. 19, 1898. No. 22418 A.

Halicarnassus Mausoleum.

Cockerell on the Mausoleum. A description by C. R. Cockerell, of an attempt to restore the Mausoleum at Halicarnassus. 1300 w. Arch, Lond—Aug 5, 1898. No. 22077 A.

Jefferson.

Jefferson as Architect. Elizabeth Porter Gould, in the *Boston Evening Transcript*. Describes the beautiful architecture of the University of Virginia, at Charlottesville. 1500 w. Arch & Build—Aug. 27, 1898. No. 22245.

Kentucky.

The Clays and Building Stones of Kentucky. M. H. Crump. Deals principally with the value of the clays for pottery, brick, &c., referring briefly to the excellent quality of the building stone. 1300 w. Eng & Min Jour—Aug. 13, 1898. No. 22089.

Revised Schedule.

The Professional Practice as to the Charges of Architects. Schedule sanctioned by the Royal Inst. of British Architects, confirmed at a general conference of architects of the United Kingdom, 1872, and revised by the Royal Institute 1898. Also discussion. 9000 w. Jour Roy Inst of Brit Archs—July 23, 1898. No. 22413 B.

CIVIL ENGINEERING.

BRIDGES.

Alexandre III.

The Construction of the Alexandre III Bridge at Paris. (Construction du Pont Alexandre III.) MM. Résal and Alby. Description of the site, and an account of the progress of the work up to the present time, with especial reference to the sinking of the caissons and the construction of the foundations. 15000 w. 7 plates. Ann des Ponts et Chaussées—1 Trimestre, 1898. No. 22337 F+G.

Arch Bridge.

The Fairmount Park Arch Bridge, Philadelphia. Illustrates and briefly describes the principal constructional features. 900 w. Eng News—Aug. 4, 1898. No. 21940.

Bridge Erection.

An Adjustable Steel Traveler. Illustrated description of a traveler capable of adjustment for bridges of various sizes and of ready shipment. 1000 w. Eng Rec—July 30, 1898. No. 21808.

The Erection of the Omaha Bridge. Illustrated description of the methods and plant used to remove the old and erect the new Union Pacific Bridge. 1500 w. Eng Rec—Aug. 27, 1898. No. 22271.

Bridge Failure.

Bridge Failure at Utica, N. Y. An account of a bridge breaking down under a street-car, with hypothesis explaining a possible cause. 1200 w. R R Gaz—Aug. 19, 1898. No. 22127.

Bridge Removal.

The Removal of an Iron Bridge. (Verschiebung einer Eisernen Brücke.) Describes the manner in which an iron truss bridge of 107 feet span and over 70 tons weight was shifted bodily to a new location about 100 feet distant in 30 minutes. Photographs of various stages of the work are given. 1000 w. Glaser's Annalen—July 15, 1898. No. 22360 D.

Brooklyn Bridge.

Buckling of Trusses on Brooklyn Bridge. Editorial on the recent anxiety concerning the safety of this bridge, describing the cause of the buckling of the four main trusses. 500 w. R R Gaz—Aug. 5, 1898. No. 21927.

Concrete Bridge.

Concrete Bridge Over the Towy. Illustrates and describes a design offered by G. A. Lundie, but not accepted by the council, giving specification. 1000 w. Engr, Lond—July 22, 1898. No. 21838 A.

Construction.

European and American Bridge Construction. Gustav Lindenthal. A fully illustrated paper, showing the rise of metallic bridge construction and the development and extension of modern methods to wide spans. 3500 w. Engineering Magazine—September, 1898. No. 22382 B.

Drawbridge.

An Electrically-Operated Drawbridge. Walter Kidde. An illustrated description of the motive power used in operating a 450-ton drawbridge over the Passaic River, at Newark, N. J., with statement of the requirements so successfully met. 1000 w. Stevens' Ind—July, 1898. No. 21852 D.

Gogra Bridge.

Gogra Bridge, Bohramghat. W. J. Turnbull. Illustrated description of a bridge over a river with badly defined banks. 400 w. Ind Engng—July 23, 1898. No. 22006 D.

Highway Bridge.

The West Braddock Bridge. Illustrated description of the design and erection of a bridge, near Pittsburg, with about 900 feet of plate girder spans, and river spans of 515, 489 and 252 feet. The expansion pockets and several other details are novel. 1700 w. Eng Rec—Aug. 13, 1898. No. 22092.

New South Wales.

Public Works in New South Wales. Brief illustrated description of a suspension bridge across Kangaroo Valley. 500 w. Arch, Lond—Aug. 19, 1898. No. 22417 A.

Railway Bridge.

Assam-Bengal Railway Bridges. Sketch design of the steel trestles of a bridge on a 10° curve, radius 573 feet, on a grade of 1 in 43, with specifications. 1000 w. Ind Engng—July 9, 1898. No. 22039 D.

Bridge Work on the Kansas City, Pittsburg and Gulf R. R. Illustrates and describes the Waddell patented form of 100-ft. through truss, the concrete piers of the Arkansas River bridge and the construction of these piers, with the engineering difficulties encountered and overcome. 6800 w. Eng News—Aug. 25, 1898. No. 22,227.

Light Railway Bridges. The Lössintz bridge on the Eppendorf-Hetzdorf state railway line, in Saxony, is illustrated and described as a noteworthy type. 1500 w. Engr, Lond—July 22, 1898. No. 21843 A.

New Railway Bridge Over the Seine. Brief illustrated description. 700 w. Engr, Lond—Aug. 19, 1898. No. 22405 A.

Suspension.

Acceptance Tests of the Suspension Bridge at Saint-Vallier. (Les Epreuves de Réception du Pont Suspender de Saint Vallier.) Report showing deflections for various positions of concentrated moving loads. The bridge is double-span, with tower in centre. 7500 w. 4 plates. Ann des Ponts et Chaussées—1 Trimestre, 1898. No. 22333 F + G.

Truss Work of Rigid Suspension Bridges. (Garde Corps des Ponts Suspendus Rigides.) M. Métour. A mathematical discussion of the stresses in the framed truss-work of a rigid suspension bridge, with tables of bending and shearing moments. 5000 w. 1 Trimestre, 1898. No. 22335 F + G.

Swing Bridge.

"Bobtail" Swing Bridge, Santa Fé Ry., Le-mont, Ill. Illustrates and describes a double-track bridge about to be erected by the Sanitary District of Chicago, over the main channel of the drainage canal. 1200 w. Ry & Engng Rev—Aug. 6, 1898. No. 21993.

Viaduct.

The Construction of the Viaur Viaduct. (Construction du Viaduct du Viaur.) MM. de Volontat and Théry. An account of the progress of the construction of the piers and scaffolding for this great railway arch over the Viaur valley, in the south of France. 2500 w. 1 plate. Ann des Ponts et Chaussées—1 Trimestre, 1898. No. 22338 F + G.

CANALS, RIVERS AND HARBORS.

Breakwater.

The New Cleveland Breakwater. Illustrated description of its design and construction. 3500 w. Eng Rec—Aug. 20, 1898. No. 22191.

Bristol Docks.

The Bristol Docks and River. Editorial discussing the proposed improvements of this port, and how the matter now stands. 1800 w. Engr, Lond—Aug. 5, 1898. No. 22059 A.

Canal Travel.

Passenger Travel on Canals. Reviews some of the types of boats used on British canals for passenger traffic, when this was the popular way of travelling. 1400 w. Engr, Lond—July 22, 1898. No. 21844 A.

Dam.

The Elastic Equilibrium in a Masonry Dam of Triangular Section. (Sur l'Equilibre Elastique d'un Barrage en Maçonnerie à Section Triangulaire.) A communication by M. Maurice Lévy, containing a mathematical discussion based upon the elastic theory, and enabling the forces to be computed with a high degree of accuracy. 2500 w. Comptes Rendus—July 4, 1898. No. 22342 D.

Partial Failure of Timber Dam near Butte, Mont. M. S. Parker. Illustrates and describes the injury that occurred during a period of high water, lasting for several days, showing that care should be taken to secure sufficient bearing surface for the timbers composing the crib to support the pressure and take up the compression. 1200 w. Eng Rec—Aug. 6, 1898. No. 21987.

Dortmund.

The Dortmund-Ems Canal. (Der Kanal von Dortmund nach den Emshäfen.) General description of this important waterway, with map, profile, and views of bridges and locks. Two articles. 5000 w. Deutsche Bauzeitung—July 23, 27, 1898. No. 22348 each B.

Dredging.

The Great Sea-Going Dredges on the Mersey Bar, Liverpool. An illustrated description of the sea-going dredge "Brancker" and its work, with an interesting account of the circumstances which led to its construction. 2000 w. Sci Am—Aug. 27, 1898. No. 22233.

Floods.

On Fighting Floods. Describes the rivers of India, classifying them as the tidal, the deltaic, the semi-deltaic, and the torrential. Discusses the crossing of these rivers and the protection of the structures. 5600 w. Ind & East Eng—July, 1898. No. 22133 D.

France.

Improvement of the System of Canals from Paris to the north of France. (Verbesserung der von Nord-Frankreich gegen Paris führenden Schiffahrts-Canale.) A. Dumas. With map of existing and projected works and a statement of past and present tonnage. 2000 w. Oesterr Monatschr f d Oeffent Baudienst—August, 1898. No. 22370 D.

Harbor Improvement.

Boulogne Harbor. Describes the improvements carried out since 1878, the cost, the machinery and working conditions of the port, navigating conditions, towing service, pilots, &c. Ill. 3000 w. Engr, Lond — July 22, 1898. No. 21840 A.

Changes in Madras Harbor and Roadstead. A recent survey has been made of this harbor, and reported information is given, with discussion of causes, comparison with previous reports, &c. 1800 w. Ind Engng—July 23, 1898. Serial. 1st part. No. 22222 D.

The Port of Calais. An illustrated account of the improvements and extension of this port, the plant and machinery. 2000 w. Engr, Lond—July 22, 1898. No. 21837 A.

Harbor Lighting.

The Electric Lighting of the Port of Rouen. (Eclairage Electrique du Port de Rouen.) M. Chateau. Especially devoted to the stationary arc lights disposed about the docks and quays of the left bank of the harbor. 3500 w. 3 plates. Ann des Ponts et Chaussées—1 Trimestre, 1898. No. 22334 F + G.

Hydraulic Observations.

The Practical Value of Water-Level Observations. (Beitrag zur Praktischen Verwertung der Wasserstands-Beobachtungen.) A. Herbst. An examination of the systematic records of river levels and a discussion of the method of comparing diagrams of such records to obtain average results. 10000 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—Aug., 1898. No. 22371 D.

Leith.

The Docks of Leith. Gives briefly the history of the construction of the docks now in existence, and the new dock works now being constructed. 2700 w. Engr, Lond—July, 22, 1898. No. 21842 A.

New York Canals.

Recent Engineering on the New York State Canals. Extract from report by E. P. North and L. E. Cooley concerning the present administration of the State Engineer's office. 1200 w. Eng Rec—Aug. 20, 1898. No. 22190.

The Canal Commissioners' Report. A summary of the report of the commission, appointed to investigate matters relating to the New York State canals, with editorial comment. 6000 w. Sea—Aug. 11, 1898. No. 22033.

The New York State Canal Inquiry. An abstract of the report of commission appointed by the governor to investigate the work done under the $9,000,000 appropriation, with editorial comment. 4700 w. Eng News—Aug. 11, 1898. No. 22046.

Nicaragua.

The Nicaragua Canal. Editorial comment on statements made in urging the need of this canal, and the United States duty concerning it. 1000 w. R R Gaz—Aug. 12, 1898. No. 22037.

River Improvement.

The Correction of the Rhine in the St. Gall-Vorarlberg Valley. (Die Korrecktion der Gewässer im St. Gallisch-Vorarlbergischen Rheinthale.) J. Wey. An account of the improvements of the Rhine as it enters the Lake of Constance including the reinforcing of the banks and the straightening of the channel by extensive canal works. Two articles. 1 plate. 4000 w. Schweizerische Bauzeitung—July 16, 23, 1898. No. 22361 each B.

Weirs.

The Sidhnai Weir, River Ravi, Punjab. An interesting description with illustrations. 2000 w. Ind & East Eng—July, 1898. No. 22135 D.

IRRIGATION.

Seepage.

Seepage from Canals. Review of important investigations showing that in Colorado alone water worth $6,000,000, at least, is lost through leakage from ditches. 1200 w. Eng Rec—Aug. 27, 1898. No. 22275.

MISCELLANY.

Cement.

Tensile Tests of Cement. Ira O. Baker. A complete statement of the method of making the tests, calling attention to such variations in practice as are in common use. Part first deals with tensile tests. 2500 w. Br Build—Aug., 1898. Serial. 1st part. No. 22230 C.

The Definition of Portland Cement. Jasper Whiting. Argument that slag cements should be classed as Portlands. 2200 w. Eng Rec—July, 30, 1898. No. 21810.

The Value of Extreme Fineness of Grinding for Hydraulic Cement. A study of this subject demonstrating the advantage of fine grinding, but showing that it is accompanied with disadvantages. 2200 w. Eng News—Aug. 18, 1898. No. 22122.

Contractor.

How to Become a Successful Contractor. Alexander MacLachlan. A few hints from one who has had twenty-five years experience. 2200 w. Builder—Aug. 20, 1898. No. 22416 A.

Elasticity.

Concerning the Law of Elastic Longitudinal Deformation. (Ueber das Gesetz der Elastischen Längenänderung Prismatischer Körper durch Zug und Druck.) W. Schüle. With many diagrams constructed from tests of materials by various observers, showing the close relation between computed and observed results. 3000 w. Zeitschr d Ver Deutscher Ing—July 30, 1898. No. 22312 D.

The Theory of Elasticity and the Study of the Strength of Materials. (Die Theorie der Elastizität, und die Bedurfnisse der Festigkeitslehre. Dr. Kirsch. A mathematical investigation of the modern theory showing its application to practical problems, as well as the close agreement between observed and computed results. 9000 w. Zeitschr d Ver Deutscher Ing —July 16, 1898. No. 22303 D.

Engineers.

The Position of United States Assistant Engineers. Editorial discussion of the position and pay of these engineers and what ought to be done to bring about a just recognition and compensation. 3000 w. Eng News—Aug. 4, 1898. No. 21943.

Foundations.

See Architecture and Building, Construction.

French Society.

The French Society of Civil Engineers. History of this society, which has recently celebrated its fiftieth anniversary, with illustrations of its new building. 3300 w. Engng—Aug. 5, 1898, No. 22068 A.

Geodesy.

The Remeasurement of the Mackinaw Base Line. Description of the measurement of a 4-mile base line by means of wires of steel and bronze 1-kilometer long. 3500 w. Eng Rec—Aug. 13, 1898. No. 22093.

Land Surveying.

A Case of Jurisprudence in Land Surveying. Ambrose E. Lehman. Gives a description of the work, with a discussion of the questions of jurisprudence involved in the case. Discussion. 8000 w. Pro of Engs' Club of Phila—July, 1898. No. 21971 D.

Reclamation.

Fraser Valley Reclamation. R. E. Palmer. Read before the Canadian Soc. of Civ. Engs. A description of two sluice boxes built by the writer when three different and distinct boxes in each case had succumbed to the effect of freshets. 3500 w. Can Eng—Aug., 1898. No. 21995.

Roads.

Apparatus and Methods Used in Testing Road Building Stone. From a report by T. C. Mendenhall, W. E. McClintock, and C. W. Ross, Highway Commissioners of Mass. Tests described were made to determine the nature of the qualities which constitute fitness or unfitness of different kinds of rocks for road making. 900 w. R R Gaz—Aug. 26, 1898. No. 22-252.

Russia.

The Status of the Engineer and Architect in Russia. (Die Standes-und Titel-Verhältnisse der Ingenieure und Architekten in Russland.) A. von Abramson. A general account of the official requirements for these bearing the title of engineer or of architect in the Russian empire, with data about Russian technical schools. 3000 w. Zeitschr d Oester Ing u Arch Ver—July 22, 1898. No. 22319 B.

Stadia Diagram.

A New Stadia Diagram. M. A. Knapp. Sketch and description of a diagram by the use of which stadia readings may be reduced to true horizontal and vertical distances much more quickly and with a satisfactory degree of accuracy. 1300 w. Eng & Min Jour—Aug 20, 1898. No. 22145.

Stress.

The Conditions of Stress. (Ueber Spannungszuständs.) Dr. Holzmüller. A mathematical discussion based both upon the Newtonian and the logarithmic treatment, a number of cases being examined; especial attention is given to thick hollow cylinders subjected to internal pressure. 5000 w. Zeitschr d Ver Deutscher Ing—August 6, 1898. No. 22313 D.

Technical Instruction.

Undergraduate Thesis Work. Edgar Marburg, at Boston meeting of the Soc. for the Promotion of Engineering Education. A protest against making the thesis entirely independent of other undergraduate work. 2500 w. Eng Rec—Aug. 27, 1898. No. 22272.

Transportation.

I. The Improvement of Transportation in Country Districts. E. E. Russell Tratman. A review of possible improvements. II Brick and Macadam Country Roads. J. E. Miller. Report on a hard road construction. III. Improving the Roads of Illinois. J. T. Schmeltzer. With report of committee, and discussion. 8500 w. Ill Soc of Engs & Surv—1898. No. 22212 D.

Tunnels.

Constructing City Street Tunnels. Illustrated description of methods adopted on the Boston subway. 3200 w. Eng Rec—Aug. 20, 1898. No. 22192.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Commerce.

New Opportunities for American Commerce. Worthington C. Ford. Gives a brief review of industrial changes, showing the difficulties to be met in developing the commerce and industry in the far east, and urging rather the looking to Cuba and Porto Rico for new opportunities in trade. 5000 w. Atlantic M—Sept., 1898. No. 22248 D.

American Industries.

American Progress in English Industries. Showing the dangers from American competition, and discussing some of the conditions of labor and other matters affecting production. 1800 w. Engr, Lond—Aug. 19, 1898. No. 22402 A.

Australia.

Australian Market for American Iron and Steel. Some information showing that it would be of advantage to American manufacturers to extend the lines of goods in this market. 1700 w. Am Mfr & Ir Wld—Aug. 19, 1898. No. 22201.

British Trade.

British Trade with This Country. Comments on the one-sided character of our trade. 700 w. Bradstreet's—Aug. 27, 1898. No. 22247.

China.

Our Last Chance in China. W. R. Lawson. Reviews the history of the trade relations between China and England, and discusses the present situation. 6300 w. Bankers' Mag, Lond —Aug., 1898. No. 22003 G.

United States Trade in North China. Extract from the annual report on the trade of China, showing the great importance of the United States trade, which has trebled since 1890. 2300 w. Cons Repts—Aug., 1898. No. 22080 D.

Coal Trade.

Coal in the East. Editorial showing that the supplies of coal from Japan, British India, and China must soon cause keen competition in eastern markets. 1200 w. Engng—Aug. 5, 1898. No. 22072 A.

Competition.

American Competition in China and Japan. Points from the report of the British Consul at Washington, showing that the United States is likely to be the greatest competitor of Britain in the Far East. 1700 w. Ind & East Eng—July, 1898. No. 22134 D.

Consular Reports.

Consuls and Foreign Trade. Editorial comment on the growing use of the consular reports, and on other matters that are helpful to foreign trade. The importance of acquiring the languages, the adapting of goods to the purchaser's needs, careful packing, &c., are considered. 1800 w. Engng—July 22, 1898. No. 21847 A.

Free Trade.

Free Trade and Foreign Policy. J. A. Hobson. Discusses the theory of free trade in England, examining the fundamental assumptions of the policy, and arguing that English prosperity does not depend upon continual expansion of foreign trade. 5000 w. Contempory Rev—Aug., 1898. No. 22021 D.

Great Lakes.

Statistics of Commerce on the Great Lakes. Statements from an interesting report issued by the Bureau of Statistics of the U. S. Treasury Dept. upon the growth of the traffic, and the reasons for it. 2300 w. Eng News—Aug. 11, 1898. No. 22047.

The Great Lakes and Our Commercial Supremacy. John Foord. An interesting account of the improvements that have made the transportation of ore through the Great Lakes so cheap as to make the primacy of the United States in the production of iron and steel secure, and the increase in trade due to the development of the trade of Lake Superior. 4500 w. N Am Rev—Aug., 1898. No. 21891 D.

India Rubber.

Investigations upon the Milk of Rubber Plants. (Recherches sur les Laits de Caoutchouc.) A posthumous paper from the documents of M. Aimé Girard, giving analyses of the milk of a variety of rubber plants, showing the proportion of caoutchouc, and the general properties of each. 3000 w. Bull de la Société d'Encour—July, 1898. No. 22341 G.

Sources of Commercial India-Rubber. Dr. D. Morris. A series of lectures confined to an investigation of the rubber plants now existing in various parts of the tropics, their geographical distribution, the conditions under which they grow, and the prospects they afford of being able to meet the increasing demand for rubber. Ill. 6700 w. Jour Soc of Arts—July 29, 1898. Serial. 3 parts. No. 21953 each A.

Iron Trade.

Review of the American Iron Trade in 1897 and in the First Seven Months of 1898. From the Annual Statistical Report of the American Iron and Steel Assn. for 1897. Low prices and the cause; great increase in exports; remarkably active consumption. 1000 w. R R Gaz—Aug. 19, 1898. No. 22129.

Japanese Investments.

Foreign Capital and Japanese Investments. Considers what will be the conditions under which foreign capital can be invested in Japan when the revised treaties have come into force. The law and the spirit in which it is likely to be administered are discussed. 3300 w. Engr, Lond—Aug. 5, 1898. No. 22058 A.

Korea.

Trade of Korea in 1897. Reports this as the most prosperous year for foreign trade, almost double the highest figure previously reached, with explanation of the increase. 4500 w. Cons Repts—Aug., 1898. No. 22079 D.

Pacific Commerce.

Commerce and Its Possibilities in the Pacific. Presents some figures given in an article in the London *Statist*, and discusses the commercial possibilities. 900 w. Bradstreet's—Aug. 20, 1898. No. 22136.

Petroleum.

The Defeat of the Oil-Kings. Robert Donald. Discussion of the report of the select committee appointed by the English House of Commons, why it was appointed, the problem to be solved, the evidence, &c. 6000 w. Contemporary Rev—Aug., 1898. No. 22022 D.

Philippines.

The Philippine Islands. Discusses the importance of these islands because of their geographical position, their trade, and the difficulties likely to arise in solving the question of their fate. 1300 w. Engng—Aug. 12, 1898. No. 22160 A.

Porto Rico.

Porto Rico's Commerce. Some statistics of the foreign trade of the island, the leading products, exports and imports. 1000 w. Sci Am—Aug. 20, 1898. No. 22111.

Prices.

Comparative Prices of 107 Staple Articles, Raw and Manufactured Products, Produce and Meats. Tabulated statement with report of the upward tendency of prices. 3500 w. Bradstreet's—Aug. 6, 1898. No. 21934.

Russia.

The Giant of the East. Discusses the great progress made by Russia of late years, not only in political and diplomatic affairs, but in the paths of industry and trade. 1500 w. Bradstreet's—July 30, 1898. No. 21822.

Trans-Siberian.

The Trans Siberian Railroad. Calls attention to the probable effect of this road on American commerce. 800 w. Bul of Bureau of Am Rep—July, 1898. No. 22004 C.

U. S. Commerce.

United States Bureau of Foreign Commerce. A brief account of what is being done in the U. S. in furnishing information helpful to trade. 1000 w. Engng—Aug. 19, 1898. No. 22293 A.

GOVERNMENTAL CONTROL.

Governmental Control.

Railroads and the Government. B. W. Arnold, Jr. Discussion of the railway problem looking toward an increase in governmental control, but offering little in the way of new suggestions. 2500 w. Gunton's Mag—Aug., 1898. No. 21851 C.

LABOR.

Compensation Act.

Workmen's Compensation Act. From the London *Times*. Explains a new departure on the part of the insurance companies undertaking insurance against employers' liability under this act. 800 w. Arch, Lond—Aug. 5, 1898. No. 22078 A.

Dangerous Employments.

Commercial Manslaughter. Gertrude Tuckwell. Describing the pitiful suffering of the workers in English potteries, and the apathy of those responsible for the conditions. 2500 w. Nineteenth Cent—Aug., 1898. No. 22019 D.

Hours and Wages.

A Five Years' Comparison of Labor as Regards Hours and Rates of Wages. Interesting information from the Fifth Annual Report of the Labor Department of the British Board of Trade. 1800 w. Ir & Coal Trds Rev—Aug. 19, 1898. No. 22401 A.

Modern Industry.

Problems of Modern Industry. Reviews a recent book by Sidney and Beatrice Webb,—a collection of essays and addresses on industrial problems, especially in England 1700 w. Builder—July 30, 1898. No. 22008 A.

Organized Labor.

The Relation of Municipalities to Organized Labor. James A. Lavery. Opposes the contract system, favors municipal ownership, favors the use of the union label. 4800 w. Pro Age—Aug. 15, 1898. No. 22096.

Southern Women.

Opportunities for Southern Women. Jerome Dowd. States the peculiar conditions which make the opportunities for employment of poor white women very much circumscribed. 1700 w. Gunton's Mag—Sept., 1898. No. 22427 c.

Wages.

Are Wages Really Falling? Discusses the report on comparative wages and prices, 1860 to 1897, as given by the Massachusetts Labor Bureau. 3500 w. Gunton's Mag—Aug., 1898. No. 21850 c.

MISCELLANY.

Arbitration.

The Anglo-American Joint High Commission. Discusses some of the questions to be brought before this Commission, and the importance of its labors. 4300 w. N Am Rev—Aug., 1898. No. 21892 D.

Combination.

The New Steel Combination. Editorial on the consolidation of the Illinois Steel Co. and the Minnesota Iron Co., with possibly other additions. 1000 w. Eng & Min Jour—Aug. 27, 1898. No. 22255.

Education.

A Higher Industrial and Commercial Education. J. B. Johnson. Abstract of the presidential address before the Society for the Promotion of Engineering Education, Boston. Describes the German mono-technic schools, considering them the explanation of that country's wonderful advancement during the last quarter century, and urges a specific scientific training for the directors of every kind of commercial and manufacturing industry in America. 3500 w. Eng News—Aug. 18, 1898. No. 22124.

Technical Education. An editorial protest against attempts to combine technical and collegiate subjects. 1400 w. Eng Rec—Aug. 20, 1898. No. 22188.

Patent Law.

Some Comparative Points of International Patent Law. J. Sinclair Fairfax. A review of the leading international features of patent law, with especial reference to the practice in England and America. 3500 w. Engineering Magazine—September, 1898. No. 22385 B.

Trusts.

Trusts vs. the Town. C. D. Chamberlin. An article discussing the effect of trusts on the rural town, with editorial reply. 2800 w. Gunton's Mag—Sept., 1898. No. 22426 c.

U. S. Manufacturing.

Distribution of Manufacturing in the United States. Cyrus C. Adams. Showing some of the causes that have determined the location and distribution of manufacturing industries. 3000 w. Chau—Sept., 1898. No. 22289 c.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Ammonium.

Ammonium Amalgam. H. C. Pocklington. Investigations of the substance known by this name with a view to settling questions relating to its character. 1200 w. Elect'n, London—July 29, 1898. No. 22009 A.

Carborundum.

Carborundum. An illustrated description of the processes used at Niagara in the manufacture of this product. 2000 w. Am Mach—Aug. 11, 1898. No. 22024.

Chromium.

The Electrochemical Behavior of Chromium. From the *Electrician*, London. Some facts obtained from the investigations of Prof. Hittorf. 1200 w. Elec, N. Y.—Aug. 3, 1898. No. 21919.

Electrolytic Soda.

The Electrolytic Production of Soda and Bleach by the Hargreaves-Bird Process. Describes the Hargreaves-Bird cell and its action, and other features of the process. 1000 w. Engng—July 22, 1898. No. 21848 A.

Electrolytic Theories.

Electrolytic Theories and Their Relation to Commercial Electro-Chemistry. Edwin Edser. Thinks England does not give the encouragement to investigation that is given by Continental governments, and notes the stimulating influence on the Continent of the theory of electrolytic dissociation in dilute solutions. 1300 w. Elec Eng, Lond—July 22, 1898. No. 21816 A.

Electro-Plating.

Arrangment of an Electro-Plating Plant. T. Ulke. Plan of the plant is given, showing how the dynamo, voltmeter, switchboards, and tanks should be connected, also directions for use and care. 1500 w. Eng & Min Jour—Aug. 6, 1898. No. 21982.

Furnace.

Applications of the Electric Furnace in the Iron Industry. (Les Applications du Four Electrique dans l'Industrie du Fer.) Emile Demenge. Giving many illustrations of historical furnaces, as well as projected devices for iron manufacture. Two articles, 3000 w. Le Génie Civil—July 30, Aug. 6, 1898. No. 22328 each D.

The Utilization of 110-Volt Electric Circuits for Small Furnace Work. Nevil Monroe Hopkins. Describes and illustrates the construction of the furnace, with detailed instructions for making small quantities of calcium carbide. 3000 w. Sci Am Sup—Aug. 27, 1898. No. 22236.

Ozone.

The Production of Ozone, and a Comparison of Its Cost with That of Other Oxidizing Agents. John B. C. Kershaw. A brief description of each of the different forms of ozonizer now before the public, with an examination of the financial aspects of the use of ozone for various purposes. 2300 w. Elec Rev, Lond—July 29, 1898. No. 22010 A.

Precious Metals.

Notes on the Electro-Chemical Treatment of Ores Containing the Precious Metals. C. E. Webber. Read before the Inst. of Elec. Engs., London. Part first reviews the history of precipitation with the aid of the electric current. Ill. 2500 w. Elec, N. Y.—Aug. 24, 1898. Serial. 1st part. No. 22219.

Tommasi Process.

Electrolytic Processes for the Extraction, Separation and Refining of Metals—The Tommasi Process. D. Tommasi. Illustrated description of this method, with statement of its advantages. 5000 w. Elec Eng, N. Y.—Aug. 11, 1898. No. 22015.

LIGHTING.

Accumulators.

The Use of Accumulators in Connection with Lighting and Traction Systems. John H. Rider. Read before the Municipal Elec. Assn. London. Considers the use of accumulators in the continuous-current lighting station, the alternating-current lighting station, the traction station, and the combined lighting and traction station. 2800 w. Elec, N. Y.—Aug. 17, 1898. No. 22108.

Distribution.

The Zipernowsky-Deri Patent. Full text of this patent for a system of transformer distribution, with both the provisional and complete specification. 4000 w. Elec Eng, Lond—Aug. 12, 1898. No. 22179 A.

Electric Plant.

Some Possibilities with an Electric Lighting Plant. C. O. Poole. Read before the Pacific Coast Gas Assn. Remarks the necessity of carrying an electric-light plant in connection with gas, and the few that pay; then points out errors in construction and operation, and shows how to make the investment profitable. Discussion. 4400 w. Am Gas Lgt Jour—Aug. 12, 1898. No. 22200.

Lamps.

On the Smashing Point of a Glow Lamp. F. W. Carter. The object of the article is to show when, in the life of a lamp, the user will have had the best value for his money. 800 w. Elec Rev, Lond—Aug. 19, 1898. No. 22421 A.

Municipal Lighting.

Municipal Lighting, Colombo. Reports new arrangements which will secure six times the quantity of light for less than the sum paid for the present supply. 1200 w. Ind Engng—July 16, 1898. No. 22140 D.

Paris Station.

A Parisian Electric-Light Station. Illustrations with description of an elaborate installation differing in many respects from American practice. 1000 w. Elec Wld—Aug. 20, 1898. No. 22109.

POWER.

Automobiles.

See Mechanical Engineering, Miscellany.

Conductors.

Aluminum as a Rival of Copper and Brass for Electrical Conductors. Alfred E. Hunt. Gives facts regarding copper and aluminum, in bars, rods, and wire suitable for electrical conductors, and calls attention to the merits of aluminum, stating its advantages and disadvantages. 3000 w. Sci Am Sup—Aug. 20, 1898. No. 22116.

Cranes.

See Mechanical Engineering, Shop & Foundry.

Detroit.

Municipal Lighting in Detroit. A review of the year's operation which shows results favorable to municipal control. 900 w. Eng Rec—Aug. 13, 1898. No. 22090.

Discharges.

The Natural Period of a Transmission Line and the Frequency of Lightning Discharges Therefrom. Charles Proteus Steinmetz. Discusses the frequency of the discharges set up in electrical-transmission lines by lightning and other disturbances. 1500 w. Elec Wld—Aug. 27, 1898. No. 22240.

Dynamos.

Sparkless Reversal in Dynamos. H. N. Allen. From the *Journal of the Institution of Electrical Engineers*. Experiments conducted with the view of finding some of the factors on which the inductance depends, and to see how nearly the results would agree with the theory. 2000 w. Elec Eng, Lond—Aug. 5, 1898. Serial. 1st part. No. 22055 A.

The Measurement of the Efficiency of Dynamos. M. Bunet. Abstract translation of an article in the *Revue de Physique et de Chimie* describing various methods of testing the efficiency and their advantages or disadvantages. 2000 w. Elec Rev, Lond—Aug. 5, 1898. No. 22056 A.

Electric Installations.

Electric Installations on Walenlake, Switzerland. C. Du Riche Preller. Describes the electric launch, Electra, which successfully navigates this lake during the summer season. Also describes the telephone cable at the same place, which is the longest telephone span in Europe. Ill. 1500 w. Engng—Aug. 5, 1898. No. 22073 A.

Electric Plant.

Electric Equipment of the Woodward Mine. W. E. Culbertson. An illustrated description of the plant used for hoisting, haulage and pumping. 1800 w. Mines & Min—Aug., 1898. No. 21951 C.

Electric Supply.

Some Suggestions Relative to Determining the Cost of Electric Supply. M. E. Turner. Abstract of paper read at the convention of the Ohio Elec. Lgt. Assn. Gives illustration of the method of charging a consumer for electrical current based on the cost of the consumer to the supply company. 1200 w. Elec Wld—Aug. 27, 1898. No. 22242.

Electrometer.

A Capillary Electrometer for Electrical Measurements. Charles Frederick Burgess. Read at Omaha meeting of Am. Inst. of Elec. Engs. Calls attention to the applicability of this instrument to practical electrical measurements, giving uses that have been tested. 1800 w. Elec Eng, N. Y.—Aug. 4, 1898. No. 21902.

Generators.

The Calculation of Alternating-Current Generators. Alexander Rothert. Part first discusses the methods of Kapp and Behn-Eschenburg, pointing out the deficiencies which sometimes cause erroneous results, for the purpose of comparison with a theory to be given which is free from such errors. 1500 w. Elec Wld—Aug. 13, 1898. Serial. 1st part. No. 22018.

Induction.

A Small Induction Coil. Howard B. Little. The writer's stated object is to describe in detail a coil whose parts are given definite proportions for definite reasons ; with hints suggested by experience in the manufacture, sale and use of such apparatus. Ill. 2300 w. Elec, Lond—Aug. 5, 1898. No. 22023 A.

Interrupters.

Mr. Tesla's Circuit Interrupters. An illustrated description of an extensive line of interrupters lately patented by Nikola Tesla for use in the production of high-frequency currents. 2800 w. Elec Wld—Aug. 20, 1898. No. 22110.

Power Measuring.

See Mechanical Engineering, Power.

Power Plant.

The Clées-Yverdon Electric Power Transmission. (Elektrische Kraftübertragung des Clées-Yverdon.) Illustrated description of this excellent plant near Neuchatel, Switzerland ; 1200 h. p. are transmitted about 25 miles. 3500 w. Elektrotech Zeitschr—July 14, 1898. No. 22363 B.

The Electric-Power and Light Plant in the Printing Office of Rudolph Mosse, Berlin. (Die Elektrische Kraft und Lichtanlage in der Buchdruckerei von Rudolf Mosse in Berlin.) B. Stein. An illustrated description of this important establishment ; 38 motors of capacity from ½ to 20 h.p. are used to operate printing presses, etc. 3000 w. Zeitschr d Ver Deutscher Ing—July 16, 1898. No. 22304 D.

Power Supply.

Electric Power in Vienna. (Der Elektromotoren-Betrieb in Wien.) Johann Pere. A description of the electric-power-supply companies in Vienna, together with tabulated statement of the extent to which power is used and the various trades among which it is divided. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—July 29, 1898. No. 22321 B.

Pump.

Electric Pump at the Lambrecht Pit. (Pompe Electrique de la Fosse Lambrecht.) Illustrated description of 100-h. p. motor operating triple-cylinder pump at the d'Anzin Mines; an efficiency of 70 per cent. is attained. 1800 w. 1 plate. Le Génie Civil—July 30, 1898. No. 22327 D.

Storage Batteries.

Recent Developments in the Applications of Storage Batteries. Joseph Appleton. Attention is called to the rapid growth during the last three years of this branch of the electrical industry, and to some of the most important and interesting applications developed. Discussion. Ill. 8000 w. Pro of Engs' Club of Phila—July, 1898. No. 21972 D.

Transformers.

Experimental Study of Transformer Diagrams. Harry E. Clifford, Nathan Hayward, and Robert Anderson. Descriptive of tests, with graphical representations. 1200 w. Tech Quar—June, 1898. No. 21819 F.

Transmission.

Long-Distance Transmission of Power. Ernst J. Berg. Abstract of paper read before the Ohio Elec. Lgt. Assn. Discusses the advantages of parallel operation, and the conditions, and disapproves of the growing use of polyphase systems, especially of the two-phase. 2000 w. Elec Wld—Aug. 27, 1898. No. 22241.

The Electrical Transmission of Energy. (Transmissions Electriques d'Energie.) A. Blondel. A very important report upon the entire subject, made by the department of Public Works to the French Chamber of Deputies, to assist in preparing legislation upon the subject. 30000 w. Ann des Ponts et Chaussées—1 trimestre, 1898. No. 22336 F + G.

Snoqualmie Falls Transmission. Illustrated description of plant to utilize the power of these falls and transmit it to Seattle and Tacoma, Washington. 2000 w. W Elect'n—Aug. 20, 1898. No. 22197.

The Mechanicville Transmission Plant. Illustrated description of a Hudson river water-power which will supply current to Schenectady and other nearby places. 1300 w. Elec Rev, N. Y.—Aug. 31, 1898. No. 22423.

TELEGRAPHY AND TELEPHONY.

Cleveland, O.

The Cleveland Telephone Company. Illustrates and describes a modern exchange and its apparatus. 1500 w. Elec Rev, N. Y.—Aug. 31, 1898. No. 22422.

Exposition.

The Telegraph at the Trans-Mississippi and International Exposition. Illustrates and describes the exhibit which shows the present state of perfection attained, and gives much of historical interest. 1400 w. W Elect'n—Aug. 13, 1898. No. 22051.

Fire Alarm.

A Great Advance in Fire-Alarm Telegraph Protection. J. W. Aydon. Read before the Assn. of Fire and Police Telegraph Supts. and Municipal Electricians. Describes a recent advance in methods which makes the outbreak of a fire and the sounding of the alarm simultaneous. 1500 w. Elec Rev, N. Y.—Aug. 24, 1898. No. 22203.

Leakage.

The Interpretation and Correction for Leakage of Conductor-Resistance Tests on Submarine Cables. Walter J. Murphy. Gives simple rules and formulæ that have been in constant application for a number of years with most satisfactory results, and proved sufficiently accurate for all practical purposes. 2500 w. Elect'n, Lond—Aug. 12, 1898. No. 22173 A.

Light Telegraphy.

Telegraphy with Light and Electricity. (Lichtelektrische Telegraphie.) Karl Zickler. Describing the author's experiments in telegraphing by the use of the ultra-violet waves of light, which, when projected upon a suitable receiver produce electrical discharges in an induction-coil circuit. Two articles, 4500 w. Elektrotech Zeitschr—July 14, 21, 1898. No. 22364 each B.

Long-Distance.

Connector for Long-Distance Telephone. (Neue Schaltung für der Sprechverkehr auf Grosse Entfernung.) M. Schwensky. An improved switch connector is used to cut out alternately the receiver or transmitter, with the result of greatly improving the distinctness. Successful tests have been made over distances of 1800 miles. 1200 w. Elektrotech Zeitschr—July 28, 1898. No. 22368 B.

Party Lines.

Party Lines. Kempster B. Miller. Discussion of this problem. Part first explains the term as applied to telephone work, and gives illustrated descriptions of some of the systems in use. 2300 w. Elec Engng—Aug., 1898. No. 22183.

Report.

Report from the Select Committee on Telephones. Authorized text of the report of committee appointed to consider questions relating to the municipalization of the telephone service in England, with editorial. 7500 w. Elect'n, Lond—Aug. 19, 1898. No. 22174 A.

Space Telegraphy.

Ducretet on Hertzian Telegraphy. Calls attention to some statements made by Ducretet in a lecture before the Société Internationale des Electriciens, and describes a new arrangement of apparatus for automatically printing messages in the Morse code. Ill. 1200 w. Elec Rev, Lond—Aug. 12, 1898. No. 22171 A.

Improvements Relating to Electric Telegraphy. Particulars from the specification of Lodge and Muirhead's patent for telegraphing by means of Hertzian waves. The invention has for its objects to provide means of obtaining greater certainty of action and an increase of distance. 1000 w. Elec Rev, Lond—Aug. 12, 1898. No. 22172 A.

Lodge's System of Syntonized Wireless Telegraphy. A detailed description of this system with illustrations. 2500 w. Elec Rev, Lond—Aug. 19,1898. No. 22420 A.

Obstruction of Hertz Waves by a Metallic Envelope. (Une Enveloppe Métallique ne se Laiose pas Traverser par les Oscillations Hertziennes.) A note by M. Branly, showing how the emission or reception of Hertz waves may be controlled by metallic envelopes; a valuable feature in connection with space telegraphy. 1000 w. Comptes Rendus—July 4, 1898. No. 22344 D.

Telegraph Property.

Submarine Telegraph Property. Some account of the past year's working of the Globe Telegraph and Trust Co., Limited. 600 w. Engng—Aug. 12, 1898. No. 22159 A.

Telegraph Work.

The Effect of Telegraph Work on the Health. From the *Lancet*, London. Extract from address of J. T. Hull, president of the Ry. Telegraph Clerks' Assn., claiming very deleterious effects. 400 w. Elec Rev, N. Y.—Aug. 24, 1898. No. 22204.

Timing Calls.

Timing Calls in Telephone Exchanges. Henry Abbott. Considers the relative merits of the different methods and appliances employed in timing calls in telephone exchanges in the United States. Showing the adaptability of the calculagraph for telephone service. Ill. 5800 w. Elec Eng, N. Y.—Aug. 25, 1898. No. 22207.

MISCELLANY.

Conductivity Method.

The Reliability of the Dissociation-Values Determined by Electrical Conductivity Measurements. Arthur A. Noyes. A criticism of an article by von Laar, in *Ztschr. phys. Chem.*, claiming that the dissociation-values calculated from electrical conductivity are incorrect, and showing that his "proofs" are not reliable. 2500 w. Tech Quar—June, 1898. No. 21818 F.

Exposition.

Department of Electricity at the Trans-Mississippi and International Exposition. Illustrates and describes the building and exhibits. 1800 w. W Elect'n—Aug. 27, 1898. No. 22258.

Galvanometers.

On the Best Resistance for a Sensitive Galvanometer. Frank A. Laws. A statement of the usual solution of the problem of obtaining the proper adjustment of the galvanometer resistance to the work in hand, and deriving a solution under conditions other than those usually imposed. 1200 w. Tech Quar—June, 1898. No. 21820 F.

Induction.

Note on the Simplification of the Law of Induction. (Bemerkungen zur Fassung des Induktionsgesetzes.) Max Breslauer. A discussion of the existing laws of electrical induction showing how they can be simplified and condensed into one comprehensive law. 1800 w. Elektrotech Zeitschr—July 28, 1898. No. 22367 B.

Phaseometer.

A Direct Indicating Phaseometer (Ueber einen Direkt Zeigenden Phasenmesser.) Th. Bruger. Describing the Hartmann & Braun apparatus, which resembles a double watt-meter, with two movable bobbins. An illustration of the instrument and diagrams of the windings are given. 1500 w. Elektrotech Zeitschr—July 14, 1898. No. 22365 B.

Radiography.

Improved Radiographic Apparatus. From *Illustrirte Zeitung*. Illustrated description of improved apparatus, with brief reference to the applications now in use. 1300 w. Sci Am Sup—Aug. 20, 1898. No. 22115.

Resistance.

Electric Resistance upon the Contact of Two Disks of the Same Metal. (Résistance Electrique au Contact de Deux Disques d'un Même Métal.) E. Branly. A detailed account of numerous experiments with disks of various metals. 1000 w. Comptes Rendus—July 25, 1898. No. 22347 D

Our Knowledge of the Value of a Resistance. W. E. Ayrton. From the London *Electrician*. On the degree of accuracy with which the resistance of a conductor can be stated in absolute measure. 2000 w. Sci Am Sup—Aug. 27, 1898. No. 22237.

Rules.

Safety Regulations for Electric Installations. (Sicherheitsvorschriften für Elektrische Starkstromanlagen.) A full reprint of the rules adopted by the German Society of Electricians at the Frankfort Convention of 1898. Two articles. 9000 w. Elektrotech Zeitschr—July 21, 1898. No. 22366 each B.

X-Rays.

Cathode Jets. C. E. S. Phillips. An account of experiments made and facts observed. Ill. 700 w. Elect'n, Lond—July 22, 1898. No. 21865 A.

The Decreasing Demand for X-Ray Apparatus. W. J. Clarke. Thinks the reasons are explained by the high price, the apparatus being too complicated, and often difficult to handle. 900 w. Elec Eng, N. Y.—Aug. 11, 1898. No. 22016.

Zeeman Effect.

New Observations upon the Zeeman Effect. (Observations Nouvelles sur le Phénomène de Zeeman.) MM. Becquerel and Deslandres. Giving the results obtained by the use of a Rowland grating and a very intense magnetic field. 3000 w. Comptes Rendus—July 4, 1898. No. 22343 D.

MARINE ENGINEERING.

Bulkhead Doors.

The Cowles System of Water-Tight Bulkhead Doors for the U. S. Cruiser "Chicago." The two methods of central control, known as the "double line" and the "single line" systems, are described; the latter being the one employed on the "Chicago." Ill. 1200 w. Eng News—Aug. 18, 1898. No. 22121.

Collisions.

Is There Any Excuse for Collisions at Sea? Hermann Herberts. A letter explaining means for detecting the presence of a vessel or iceberg, and how their movements may be followed. 3200 w. Sci Am Sup—Aug. 6, 1898. No. 21933.

Space Telegraphy and Collisions at Sea. (Télégraphie sans Vil et Collisions en Mer.) A note by M. Branly in connection with the suggestion of MM. Berget and Décombe showing how a Hertz exciter and Branly coherer may be used to give warning of approaching ships, and prevent collisions. 1000 w. Comptes Rendus—July 18, 1898. No. 22346 D.

Colomes Stopper.

The Colomés Life and Ship Protector. Illustrates and describes this cellulose plug for closing shot holes, and explains the usefulness of the device. 1700 w. Sci Am—Aug. 20, 1898. No. 22113.

Ferryboats.

Recent Improvements in Mississippi River Ferryboats at St. Louis. William H. Bryan. A statement is given, of the conditions of service required with review of types used in the past, and illustrated description of the latest boats. 3300 w. Marine Engng—Aug., 1898. No. 21973 C.

Governors.

Marine-Engine Governors. (Schiffsmaschinenregler.) A paper by Hr. Dubbel showing the importance of governors for marine engines, with descriptions of some of the more recent forms and discussing the conditions of governing for multiple-expansion engines. 2000 w. Zeitschr d Ver Deutscher Ing—July 23, 1898. No. 22309 D.

High Pressure.

High-Pressure Marine Engines. Editorial on some of the difficulties to be met in using high pressures. 1600 w. Engr, Lond—Aug. 5, 1898. No. 22060 A.

High Speed.

High-Speed Marine Engines. (Schiffsmaschinen mit Hoher Kolbengeschwindigkeit.) A paper by Inspector Eickenradt before the German Society of Mechanical Engineers, discussing especially the methods of counterbalancing in order to diminish vibration at high speeds. Two articles, 4500 w. Glaser's Annalen—July 1, 15, 1898. No. 22359 D.

Launch.

Navigation on African Lakes. C. Du Riche Preller. Brief description of an aluminum launch constructed for the Victoria Nyanza. 400 w. Engng—Aug. 12, 1898. No. 22161 A.

Light House.

Alguada Reef Light-House. Information and description relating to one of the most important light-houses off the coast of Burmah. 1600 w. Ind Engng—July 16, 1898. No. 22139 D.

Merchant Marine.

The Mercantile Shipbuilding of the World. A review of the outputs of the various shipbuilding countries for the last year, with comparison of previous years, based on statistics from Lloyd's Register. 2000 w. Engs' Gaz—Aug., 1898. No. 21954 A.

Naval Architecture.

Notes on Naval Architecture. Joseph R. Oldhorn. Quotes from paper of Sir Edward J. Reed, and the discussion called out, briefly describes the Japanese battleship "Shikishima"; comments on American warships, &c. Discussion. 6000 w. Jour Ass'n of Engng Soc's—July, 1898. No. 22218 C.

Position Indicator.

Means for Detecting the Presence of a Ship or Iceberg. Hermann Herberts. Outlines methods for study with the view of avoiding collisions at sea. Describes an apparatus consisting of a thermopile and connections. 2700 w. Elec Eng, N. Y.—Aug. 4, 1898. No. 21901.

Propeller.

Screw-Propeller Pattern. I. McKim Chase. Illustrates and describes a method of making a pattern for a screw propeller with separable blades. 2000 w. Mach, N. Y.—Aug., 1898. No. 21889.

Shipping.

The Supply and Waste of Shipping. Editorial comment on the number and tonnage of British vessels removed from active service during 1897, with a comparison of British waste with the rest of the world. Shows a gross decrease of nearly 52,000 tons when compared with 1896. 1300 w. Engng—Aug. 5, 1898. No. 22071 A.

Steam Pipes.

The Use of Copper Steam Pipes. Review of latest British investigations. 600 w. Eng Rec—July 30, 1898. No. 21806.

Steamship.

The Steamship "Kaiser Wilhelm der Grosse." (Le Paquebot "Kaiser Wilhelm der Grosse.") Illustrated description of the great Atlantic liner, with views of the interior, and data about the growth of the North German Lloyd Company. 3500 w. 1 plate. Le Génie Civil—Aug. 6, 1898. No. 22329 D.

The Union S. S. Co.'s Twin-Screw R. M. S. "Briton." An account of a visit to this steamship, with illustrations and description. 700 w. Steamship—Aug., 1898. No. 21958 A.

Twin-Screw Steamer Duke of Cornwall. Illustrated description of the latest vessel added to the fleet in service between England and the North of Ireland. These are all vessels of the highest class, resembling Atlantic liners. 2000 w. Engr, Lond—July 29, 1898. No. 21970 A.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Bracing.

Boiler-Brace Tests. A. F. Huston. Describes tests and gives points ascertained regarding the strength of rivets. Ill. 1000 w. Power—Aug., 1898. No. 21905.

Economy.

Fuel and Boiler Economy at the Saar Collieries. From a communication by Berginspektor Osterkamp to *Glückauf*. Describes the manner of conducting the steam boilers and the experience gained. 1700 w. Col Guard—July 29, 1898. No. 21967 A.

Efficiency.

Variation in Boiler Efficieny. William D. Ennis. Describes tests recently made by the writer at the electric station of the Consolidated Gas Company of New Jersey, Long Branch, making an attempt to divide the tests into periods for comparison. 1400 w. Power—Aug., 1898. No. 21904.

Explosions.

Accidents to Steam Boilers during 1896. (Accidents d'Appareils à Vapeur en 1896.) The official report of accidents to steam apparatus, in tabulated form, with plates of illustrations showing the nature of the explosions. 6000 w. 3 plates. Ann des Ponts et Chaussées—1 trimestre, 1898. No. 22340 F+G.

The Buffalo Boiler Explosion. E. E. Williams. Illustrated description of the explosion at the Niagara factory of the National Starch Mfg. Co. at Buffalo, N. Y., where 7 were killed and 21 injured. 1000 w. Sci Mach—Aug. 1, 1898. No. 21825.

Fallacies.

Fallacies Concerning Boilers. Editorial discussing a few of these. 1800 w. Engr, Lond—Aug. 12, 1898. No. 22069 A.

Fan Blowers.

The Design of Fan Blowers. Walter B. Snow. A discussion of fan blowers and the theoretical considerations which govern their design. 3000 w. Mach, N. Y.—Aug., 1898. No. 21888.

Feed-Water

Water-Softening and Purification by the Archbutt-Deeley process. Leonard Archbutt. Read before the British Inst. of Mech. Engs. An explanation of the process and the chemical changes; also referring to other processes and to points bearing upon the formation of boiler scale. 5500 w. Col Guard—Aug. 12, 1898. No. 22166 A.

Fuel.

Gas Coke for Generator Fuel. C. M. Converse. Read before the Pacific Coast Gas Assn. Relates the difficulties met in learning how to use this fuel, and how they were overcome. Discussion. 3800 w. Am Gas Lgt Jour—Aug. 22, 1898. No. 22199.

See Mining and Metallurgy, Miscellany.

Gauges.

How to Read Gauges. Alfred Siebert. Considers pressure gauges, glass gauges, the oil receiver, and the liquid receiver, and how trouble was located. 2200 w. Ice & Refrig—Aug., 1898. No. 21827 C.

Grates.

The Relation of Air Space in Grates to Boiler Economy. Editorial discussion of influence of variations in air space as shown by tests. 800 w. Eng Rec—July 30, 1898. No. 21804.

Hardening.

Continuous Hardening Furnace. An illustrated description of a furnace designed for hardening bicycle balls, but applied also to other work. 700 w. Engng—Aug. 19, 1898. No. 22291 A.

Plate Welding.

Boiler-Plate Welding. W. D. Wansbrough. From *The Boilermaker.* Explains the restrictions placed on the use of welded boiler seams in England, stating their advantages, and gives practical directions for welding the longitudinal seams of a boiler flue or cross tube. Ill. 4300 w. Mech Wld—Aug. 12, 1898. No. 22152 A.

Powdered Coal.

New Coal-dust Furnaces. Describes and illustrates recent devices, differing somewhat from those hitherto proposed. Considers the Pinther system; the Russell, Lester and Ernst systems; the Peck and Patterson systems, and the Juckes furnace. 1400 w. Ir & Coal Trds Rev—July 29, 1898. No. 21965 A.

Scale.

Mineral Oils as Scale Preventives. Information concerning the nature and action, and the best way of using, petroleum derivatives. 1900 w. Locomotive—July, 1898. No. 22097.

Smoke Prevention.

The Hinstin Smoke-Consuming Furnace. From *La Revue Technique.* Illustrated description. 600 w. Col Guard—July 22, 1898. No. 21833 A.

The Suppression of the Production of Smoke by Boiler Furnaces. (Suppression des Fumées Produites par les Foyers des Chaudières à Vapeur.) A. Boyer-Guillon. A condensation of the report of the Paris Smoke-Prevention Commission with illustrations of the apparatus and of the successful furnaces in the competition. two articles. 6000 w. Le Génie Civil—July 16, 23, 1898. No. 22325 each D.

Specifications.

Boiler-Steel Specifications. A collection of figures selected from specifications under which a large quantity of boiler steel is being purchased for both locomotive and stationary boilers, with comments and editorial. 2000 w. Ry & Engng Rev—Aug. 27, 1898. No. 22281.

Steam.

Making Steam in Boilers. A comparison of the water-tube and tank systems. 1000 w. Bos Jour of Com—Aug. 20, 1898. No. 22186.

Superheating.

The Schmidt Superheating System. Translated from *Portefeuille Economique des Machines.* Illustrates and describes a construction that ensures perfect circulation of the firebox gases, thus avoiding troubles from burned tubes, separated joints, leakage, &c. 1400 w. Mech Wld—July 29, 1898. No. 21955 A.

Tests.

Tests of Boilers, Engines, Elevators, and Ventilating Plant, Chicago Public Library. Interesting portions of the report of George H. Barrus, who was retained by the board of directors to make a complete test. An important article, showing results that led to many improvements. Ill. 3500 w. Eng Rec—Aug. 6, 1898. No. 21989.

Water-Tube.

The Miyabara Water-Tube Boiler. Illustrates and describes a water-tube boiler designed by the constructor officer of the Imperial Japanese Navy. 700 w. Engr, Lond—Aug. 19, 1898. No. 22404 A.

Water-Tube Boilers (Wasserröhrenkessel.) A paper by Hr. Ulrici, reviewing the subject generally and giving special information concerning the Steinmüller boiler with data and results of tests. 1500 w. Zeitschr d Ver Deutscher Ing—July 16, 1898. No. 22306 D.

COMPRESSED AIR.

Compressor.

The Strnad Air Compressor at the Maybach Mine. (Luftkompressionsmaschine System "Strnad" auf Grube Maybach.) Illustrated description of double-cylinder tandem air compressor, with Corliss valves on air cylinders. Full details are given, together with indicator diagrams. 2000 w. 1 plate. Glückauf—July 30, 1898. No. 22353 B.

Mine Locomotive.

The Compressed-Air Mine Locomotive. Part first gives a brief statement of the advantages urged by those in favor of compressed-air haulage, and describes various types of locomotives used. Ill. 2800 w. Ir & Coal Trds Rev—Aug. 5, 1898. Serial. 1st part. No. 22057 A.

Pneumatic Tubes.

Recent Progress in the Development of Pneumatic Dispatch Tubes. B. C. Batcheller. Brief reference is made to European systems, showing progress to 1893; an account of the 6-inch tubes put into operation in Philadelphia, and the 8 inch tubes in New York, with an explanation of the theory. Ill. 6500 w. Jour Fr Inst—Aug., 1898. No. 21910 D.

Sand Blast.

The Sand-Blast Process as Applied to the Cleaning of the Walls of Pardee Hall, Lafayette College. J. C. Heckman. Illustrates and describes the application of the sand blast to the cleaning of stone walls from smoke stains after a fire. 1100 w. Compressed Air—Aug., 1898. No. 21914.

Science.

Recent Science. Prince Kropotkin. Parts first and second deal with the progress made in liquefying air and gases; parts third and fourth, with motive power and transmission. 9800 w. Nineteenth Cent—Aug., 1898. No. 22020 D.

Tests.

Tests of a King-Reidler Air Compressor at the Rose Deep Mine, South Africa. L. I. Seymour. Read before the South African Assn. of Engs. and Arch'ts. Data of tests made, with summary of results and explanatory remarks. 1500 w. Compressed Air—Aug., 1898. No. 21915.

ENGINES AND MOTORS.

Blowing Engines.

Blowing Engines. James Proctor. Read before the South Staffordshire Inst. of Iron and Steel-Works Managers. Deals only with blowing engines as connected with blast furnaces. Ill. 2500 w. Engr, Lond—Aug. 5, 1898. No. 22062 A.

Breakdowns.

Mill Engine Breakdowns. Items of interest from the chief engineer's report to the Engine, Boiler and Employers' Liability Insurance Company, Limited, describing causes of breakdowns in steam and gas engines, &c. Ill. 1600 w. Mech Wld—Aug. 19, 1898. No. 22286 A.

Compound Engine.

Compound Engine 1500 Horse Power. (Verbunddampfmaschine von 1500 P S.) A short description of this handsome vertical engine with photograph and plate of detailed drawings. 500 w. 2 plates. Zeitschr d Ver Deutscher Ing—July 16, 1898. No. 22305 D.

The 1500-Hp. Engines for the Berlin, Germany, Electric Works. From the *Zeitschrift des Vereines Deutscher Ingenieure*. Illustrated description of the cross-compound engines built for this company which operates the five central lighting stations of Berlin. 600 w. Eng News—Aug. 25, 1898. No. 22226.

Cylinders.

Cylinders for Compound Engines. Tables for computing the sizes of cylinders for compound engines arranged for both condensing and non-condensing, with boiler pressures varying by increments of 10 lbs. from 80 to 250 lbs. per square inch above the atmosphere. 600 w. Mech Wld—July 29, 1898. No. 21956 A.

Diesel.

The Diesel Heat Engine. Illustrated description of the engine and its operations. 1300 w. Am Eng & R R Jour—Aug., 1898. No. 21878 C.

Engines.

Westinghouse Steam and Gas Engines and Generators. An account of a visit made to inspect some of the new engines and electrical apparatus about to be shipped to England. 800 w. R R Gaz—Aug. 5, 1898. No. 21926.

Engine Shafts.

The Evolution of the Modern Engine Shaft. H. F. J. Porter. Gives the history of the development and processes for making steel shafts. Ill. 5000 w. Power—Aug., 1898. No. 21906.

Gas Engines.

Some Notes on the Modern Commercial Gas Engine. Carmichael Peebles. Read at meeting of the North British Assn. of Gas Managers. Gives briefly the history of the Otto cycle gas engine, the changes since first brought out, improvements in details, &c. 4500 w. Gas Wld—July 30, 1898. No. 22013 A.

Tests of an 100-H.P. Otto-Crossley Gas-Engine. Abstract of the graduating thesis of E. H. Brown of the Worcester Polytechnic Inst. Description of the plant and tests with conclusions. 1700 w. R R Gaz—Aug. 26, 1898. No. 22250.

Governors.

The Design and Setting of Shaft Governors. J. C. Cornock. Part first discusses the prevention of internal friction, the arrangement of the spring, &c. Ill. 1400 w. Mech Wld—Aug. 12, 1898. Serial. 1st part. No. 22151 A.

Heat Motor.

The High-Pressure Heat Motor. (Der Hochdruckwärme Motor.) A paper by J. Lüders discussing the increase of working pressure in internal-combustion motors, with especial reference to the thermodynamics of the Diesel motor. 6000 w. Zeitschr d Ver Deutscher Ing—July 9, 1898. No. 22302 D.

Indicator.

Remarks on the Steam-Engine Indicator. W. S. Bailey. Read at a meeting of Inst. of Engs. and Shipbuilders at Hong Kong. History of the invention and improvement in details, the manner of use, the diagrams, and general usefulness. 5500 w. Steamship—Aug., 1898. No. 21959 A.

Indicator Cards.

The Point of Cut-Off. Editorial on proper location of this point on the card and its importance. 700 w. Eng Rec—Aug. 27, 1898. No. 22269.

Steam Engine.

Horizontal Tandem-Compound Steam Engine. Illustrated description of an engine possessing many features of interest, special devices for obtaining steady running at a pre-determined speed, with a minimum of attention. 2700 w. Prac Eng—Aug. 12, 1898. No. 22175 A.

Vacuum.

High Vacuum in Condensing Engines. Editorial discussion concluding that in an engine which has tight valves and pistons, and is provided with condensing apparatus and air pump suitably designed for the work, the higher the vacuum the better will be the economy. 700 w. Eng Rec—Aug. 6, 1898. No. 21985.

Valve Gear.

Corliss Valve Gear. Editorial on the difficulties standing in the way of the production of a positive Corliss gear. 1500 w. Engr, Lond—Aug. 19, 1898. No. 22408 A.

Winding Engines.

Powerful Winding Engines at the Preussen Colliery, Westphalia. E. Tomson. From a communication to the jubilee meeting of the

Liége Engs.' Assn. Side elevation, plan and dimensions, with description of the arrangement adopted and statement of its advantages. 3200 w. Col Guard—July 22, 1898. No. 21831 A.

POWER AND TRANSMISSION.

Dynamometer.

Some New Forms of Transmission Dynamometer. John J. Flather. Illustrated description of a type of dynamometer which has given satisfaction under a variety of conditions in the laboratory and shop. 1200 w. Mach, N. Y.—Aug., 1898. No. 21886.

Gravity System.

The Holly Gravity Return System. Illustrates and describes the recent installation in the Twenty-sixth St. power station of the Edison Electric Illuminating Co., of New York. 1700 w. Sci Am—Aug. 20, 1898. No. 22112.

Power Cost.

The Comparative Cost of Steam and Water Power. William O. Webber. A comparison based upon the most recent data, showing the various items in detail and the great reductions in the cost of power both for steam and water. 3000 w. Engineering Magazine—September, 1898. No. 22383 B.

Power Gas.

Power from Producer Gas. W. H. Booth. Describes the new gas plant installed by Mr. Arthur Parritt, at Birstal, in Yorkshire, commenting on the advantages. 2300 w. Am Mach—Aug. 4, 1898. No. 21935.

The Direct Utilization of Blast-Furnace Gases. (Utilisation Directe de Gaz des Hauts Fourneaux.) Aug. Dutreux. A general review of the results thus far attained at Seraing and elsewhere, with excellent photographs of motors of 150 to 250 h. p. for use with furnace gases. Two articles. 4500 w. Le Génie Civil—July 23, 30, 1898. No. 22326 each D.

Power Measuring.

Electric Motors for Measuring Power in Place of Transmission Dynamometers. E. B. Raymond. Extract from discussion at meeting of the New England Cotton Mfrs. Assn. Also extract from discussion by Calvert Townley. Describes methods. 2300 w. Power—Aug., 1898. No. 21907.

Water Power.

Water-Power Development by the Lake Superior Power Co., at St. Mary's Falls, Mich. Describes the plant of this company on the American side of the river, at Sault Ste. Marie, Mich., which is to be completed in two years. Ill. 3300 w. Eng News—Aug. 4, 1898. No. 21941.

SHOP AND FOUNDRY.

Arc Works.

The New Arc Works at Chelmsford. Illustrates and describes the new works of Messrs. Crompton & Co. for the manufacture of high-class electrical plant. 3700 w. Elec Eng, Lond —Aug. 5, 1898. No. 22054 A.

Brass.

The Influence of Bismuth on Brass, and its Relation to Fire-Cracks. Erwin S. Sperry. Describes experiments made while investigating this subject giving results and conclusions. Ill. 1800 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22265 D.

Brazing.

Electrical Shop Work. B. F. Fells. Brief illustrated description of the best methods of setting up and using a brazing outfit. 900 w. Elec Wld—Aug. 13, 1898. No. 22017.

Cranes.

Electric Cranes. (Elektrisch Betriebene Krane.) Chr. Eberle. Many details of electric traveling cranes, with a plate of single-motor crane of 12-tons capacity, and illustrations of a 65-ton Oerlikon crane. 5000 w. 1 plate. Zeitschr d Ver Deutscher Ing—July 23, 1898. No. 22307 D.

Cupola Practice.

Modern Cupola Practice, with Special Reference to the Discussion of the Physics of Cast-Iron. Bertrand S. Summers. Outlines the effects of the metalloids, mentions some new ideas which recent practice has developed, giving some results of practical tests. 7000 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22260 D.

Ellipsograph.

The Mundo Ellipsograph. Morris Fulton. A sketch and brief description of the ellipsograph made and used at the Mundo Iron Works, and found convenient by the draftsmen. 1600 w. Am Mach—Aug. 11, 1898. No. 22026.

Files.

The Manufacture of Files. (Die Herstellung der Feile.) Illustrated account of the process of file making. including both hand and machine cutting, with illustrations of German file-cutting machines. 3000 w. Stahl und Eisen—Aug. 1, 1898. No. 22358 D.

Forging.

The Forging and other Presses at the Kalk Machine Works. (Schmiede und Andere Pressen der Kalker Werkzeugmaschinenfabrik.) A paper by Herr Meune with valuable data and indicator diagrams showing the action of hydraulic forging presses performing given operations. 3000 w. Zeitschr d Ver Deutschr Ing—August 6, 1898. No. 22315 D.

Foundry Conditions.

Foundry Conditions Abroad. Martin Fox. Some general impressions of the conditions of molders and of the British foundry trade. 1200 w. Ir Trd Rev—Aug. 25, 1898. No. 22243.

Guides.

Lining Guides. Ira A. Moore. Describes how the work should be done. Ill. 1600 w. Loc Engng—Aug., 1898. No. 21884 C.

Hinge-Bolts.

The Use of Hinge Bolts on Movable Covers. (Boulons à Charnière des Obturateurs Amovibles.) MM. Polonceau and Walckenaer. Reviewing a large number of accidents which have occurred from the use of hinged bolts to secure covers upon vessels containing steam under pressure. Illustrations of many cases are given. 10000 w. Ann des Ponts et Chaussées—1 Trimestre, 1898. No. 22339 F+G.

Index-Plates.

Making Original Index Plates. William Baxter, Jr. Illustrated description of two methods devised by the writer. 1000 w. Am Mach—Aug. 4, 1898. No. 21937.

Lathes.

A Shafting Lathe. Describes a lathe having some new features, which is intended both for general lathe work and for turning shafting, and arranged so as to be quickly changed from one kind of work to the other. Ill. 700 w. Am Mach—Aug. 18, 1898. No. 22118.

A Steady-Pin Lathe. A. H. Cleaves. Illustrates and describes a special tool used by watch makers, but also useful for other work. 700 w. Am Mach—Aug. 11, 1898. No. 22025.

Pipes.

Pipes and Fittings. Tecumseh Swift. Calls attention to some particulars needing improvement, offering suggestions. 1200 w. Am Mach—Aug. 11, 1898. No. 22027.

Rack.

Originating the Hoe Rack. John Randol. Illustrates and describes the making of a machine requiring great accuracy. 4000 w. Am Mach—Aug. 18, 1898. No. 22119.

Riveting.

Systems of Riveting for Boiler Construction. (Entwerfen von Dampfkesselnietungen.) H. Dieckhoff. A mathematical investigation, comparing the rules of the City of Hamburg, the German Lloyds, the Bureau Veritas, and the Lloyds Register with diagrams of many arrangements showing the percentage of full strength obtained. 3000 w. Zeitschr d Ver Deutscher Ing—August 6, 1898. No. 22314 D.

Steam Pipes.

See Marine Engineering.

MISCELLANY.

Aerodynamics.

The Aerodynamics of a Thin Plate, and the Conditions of its Descent. (Der Aerodynamische Schwedzustand einer Dünnen Platte und deren Sinkgeschwindingkeit.) F. R. v. Loessl. A mathematical investigation with diagrams of experiments, furnishing valuable data in connection with aerodynamical problems. Three articles. 10000 w. Zeitschr d Oesterr Ing u Arch Ver—July 29, Aug. 5, 12, 1898. No. 22322 each B.

Aeronautics.

The "Avion." From *L'Illustration*. Illustrated description of an apparatus devised and constructed by M. Ader, a French engineer. 1500 w. Sci Am—Aug. 27, 1898. No. 22235.

Automobiles.

Electric Carriages. J. T. Niblett. Gives some recent improvements in accumulators and their application to traction on common roads. 2500 w. Elec Rev, N. Y.—Aug. 17, 1898. No. 22099.

French Tests of Electric Cabs for City Service. Reports an interesting and valuable test of electric cabs, carried out in Paris. Eleven carriages were entered. Ill. 1000 w. Elec Eng, N. Y.—Aug. 4, 1898. No. 21903.

The "American" Electric-Motor Vehicles. Illustrates and describes some of these vehicles. 1300 w. Elec Eng, N. Y.—Aug. 18, 1898. No. 22104.

The Automobile Race between Paris and Amsterdam. (La Course d'Automobiles Paris-Amsterdam-Paris.) A general description of this important road competition with numerous photographs of the competing machines. Serial. 1st part. 4000 w. La Revue Technique—July 25, 1898. No. 22331 D.

The "Cyclope" Petroleum-Spirit Motor. General view, detail drawings and description. 1000 w. Ind & Ir—Aug. 19, 1898. No. 22411 A.

The Doré Electrical Motor-Cab. Brief illustrated description. 600 w. Ind & Ir—Aug. 19, 1898. No. 22412 A.

The Landry-Beyroux Motor Carriage. Illustrated description of a motor carriage at the recent Paris exhibition which presents several novel features. 800 w. Ind & Ir—Aug. 12, 1898. No. 22167 A.

Toward's Steam Tractor. Illustrated description of a steam tractomotor built at Newcastle-on-Tyne. 700 w. Engr, Lond—Aug. 19, 1898. No. 22407 A.

Balancing.

An Instructive Mechanical Failure. Wilfred Lewis. Illustrated discussion of an alleged improvement in balancing a locomotive driving-wheel. 4500 w. Jour Fr Inst—Aug., 1898. No. 21911 D.

Bicycles.

The Efficiency of Bicycles. R. C. Carpenter. Part first explains the meaning of the term "efficiency" as used, and discusses the efficiency of bearings and of driving mechanism, giving diagrams. 2500 w. Engng—Aug. 19, 1898. Serial. 1st part. No. 22294 A.

The Increasing Weight of the Bicycle. Editorial comment on the increase in weight of American wheels, considering it a distinctly retrograde step. 1400 w. Sci Am—Aug. 27, 1898. No. 22232.

Combing.

Combing Machines. Illustrated description of an interesting improvement in this class of machinery. 900 w. Bos Jour of Com—Aug. 20, 1898. No. 22187.

Composition of Water.

James Watt and the Discovery of the Composition of Water. T. E. Thorpe. The Watt Memorial Lecture, delivered in the Watt Memorial Hall, Greenock. From *Nature*. A statement of the essential facts that led to the recognition of the true chemical nature of water. 7000 w. Sci Am Sup—Aug. 6, 1898. No. 21932.

Crank Pins.

Stresses in Crank Pins and Axles. Explaining the stresses at work to produce rupture. 1000 w. Loc Engng—Aug., 1898. No. 21885 C.

Hoisting.

The Brown Hoisting and Conveying Machinery. (Die Brownschen Hebe- und Fördervonichtingen.) Axel Sahlin. A paper before the Eisenhüttenleute, describing this well-known American system of conveying materials. 3500 w. Zeitschr d Ver Deutscher Ing—July 9, 1898. No. 22300 D.

Inertia.

A New Inertia Indicator. Wilfred Lewis. Read before the Engs'. Club of Phila. Describes the instrument and illustrates its application. 900 w. Ir Age—Aug. 4, 1898. No. 21908.

Loading.

Some Modern Methods of Loading Coal. Illustrates and describes the Werner system and the Wellman-Seaver system. 1200 w. Ir & Coal Trds Rev—July 29, 1898. No. 21964 A.

Museum.

The Centenary of the Conservatoire des Arts et Métiers. (Le Centenaire du Conservatoire des Arts et Métiers.) A historical account of this famous French mechanical museum and educational institution, with illustrations of various portions of the buildings. 1500 w. Le Génie Civil—July 16, 1898. No. 22324 D.

Pantagraph.

A New Pantagraph. A. H. Cleaves. A description of the machine with illustrations; also a note from the inventor regarding the principles upon which the machine is based. 800 w. Am Mach—Aug. 4, 1898. No. 21936.

Pump.

See Electrical Engineering, Power.

Refrigeration.

Carbonic-Acid Refrigerating Machines. (Les Machines Frigorifiques à Acide Carbonique). P. de Mériel. An illustrated description of the Escher, Wyss & Co. refrigerating machines, operating with carbonic-acid gas, and extensively used in the French breweries. 2000 w. La Revue Technique—July 25, 1898. No. 22329 D.

Recent Improvements in Refrigerating Machinery. (Neuerungen und Fortschritte auf dem Gebiete der Kälteerzeugung.) Prof. H. Lorenz. With especial reference to improvements in compressors and valves, with many detailed illustrations. 4500 w. Zeitschr d Ver Deutscher Ing—July 30, 1898. No. 22311 D.

Refrigeration and Thermodynamics. J. E. Johnson, Jr. Part first discusses the relation between science and practice, steam engineering, refrigeration and thermodynamics, &c. 3000 w. Ice & Refrig—Aug., 1898. Serial. 1st part. No. 21826 C.

Shop Costs.

Effective Methods of Finding and Keeping Shop Costs. Henry Roland. A very full exposition of the system adopted in the works of an extensive electrical-manufacturing company, with forms and details of application. 4500 w. Engineering Magazine—September, 1898. No. 22389 B.

Spiral.

The Hyperbolic Spiral. Walter K. Palmer. A description of the properties of the hyperbolic spiral, showing its use in connection with the drawing board for the solution of geometrical and trigonometrical problems. 3000 w. Kan Univ Qr—July, 1898. No. 22216 D.

Thermodynamics.

Heat Diagrams and Cycles of Gases. (Das Wärmediagramm des Gase und deren Kresprozesse.) Ugo Ancona. A mathematical discussion of the entropy diagram, with an examination of special cases. 3000 w. Zeitschr d Ver Deutscher Ing—July 23, 1898. No. 22308 D.

Thermometry.

Recent Work in Thermometry. C. Chree. A brief account of recent progress. 5000 w. Nature—July 28, 1898. No. 21957 A.

Tyres.

Pneumatic v. Iron Tyres. From a paper read before the Société des Ingénieurs Civil, by M. Michelin, giving the results of some experiments made to determine the relative qualities of pneumatic and iron tyres. 400 w. Prac Eng —July 29, 1898. No. 22014 A.

Valves.

A Quick-Acting Valve Gear. Describes an invention of A. Long, possessing qualities worth examining. Ill. 500 w. Bos Jour of Com—Aug. 6, 1898. No. 21999.

MILITARY ENGINEERING.

Armor Plate.

Test of a Six-Inch Experimental Krupp Plate. Illustrates and describes the tests at the Indian Head Proving Ground, reporting the results. The plate was made by the Carnegie Company. 1500 w. Sci Am—Aug. 27, 1898. No. 22234.

The Carnegie Krupp Armor Plate. W. L. C. Reports the test of the first armor plate made in this country under the Krupp process, the results being most gratifying. Ill. 700 w. Ir Age—Aug. 18, 1898. No. 22107.

Battleships.

Alabama Class Battleships. Illustrated description of the Alabama, Illinois and Wisconsin, sister ships, soon to be added to the U. S. navy. 1600 w. Marine Rev—Aug. 11, 1898. No. 22030.

Battleships Kearsarge and Kentucky. An interesting illustrated description of these two vessels nearing completion, with their equipment. 3 plates. 5500 w. Marine Rev—Aug. 11, 1898. No. 22028.

Higher Speed for Our New Battleships. Editorial on the necessity of future battleships being vessels of large coal endurance and high speed. 1400 w. Sci Am—Aug. 6, 1898. No. 21916.

In the Engine Room of the Texas. Kenneth McAlpine. From the *N. Y. Evening Sun.* Interesting description of the work in the engine-room during the engagement with Cervera's fleet. 1600 w. Am Mach—Aug. 25, 1898. No. 22225.

The Performance of the "Oregon's" Engines on Their Great Run of 15000 Knots. A letter from C. N. Offley, published in the *N. Y. Sun.* An interesting account of the trip. 2300 w. Sci Am Sup—Aug. 27, 1898. No. 22239.

The "Texas" in Action. Reviews briefly the history of this warship, with illustrated description of the damage wrought by Spanish shells during the Santiago engagement. 1800 w. Sci Am—Aug. 20, 1898. No. 22114.

The Work of the Battleship Oregon. An account of the remarkable trip from the Pacific Coast and the performance after joining the fleet and during the battle at Santiago, with list of officers. 2800 w. Am Mach—Aug. 25, 1898. No. 22224.

Cervera's Fleet.

The Battle with Cervera's Fleet Off Santiago. Winston Churchill. Compares the training for the navy in America and Spain ; the race differences ; the ships; giving incidents of the battle and pictures of brave deeds. Ill. 7800 w. Am Rev of Revs—Aug., 1898. No. 21868 C.

Cruisers.

Ships of the Armored-Cruiser Type. An account of the work done by this type of vessel in the naval engagement at Santigo, showing their efficiency, and referring to the probability of others being constructed for the U. S. navy. 1600 w. Marine Rev—Aug. 11, 1898. No. 22031.

Finances.

Cost and Finances of the Spanish War. Charles A. Conant. Reviews appropriations made by Congress, discussing the actual cost, contingent expenses, the popular loan, etc. 5500 w. Am Rev of Revs—Sept., 1898. No. 22279 C.

Floating Hospitals.

Our Ambulance Ships. Illustrates and describes the "Solace" and "Relief," of the U. S. navy, and their equipment for hospital service. 2000 w. Marine Rev—Aug. 11, 1898. No. 22029.

Floating Shop.

U. S. S. Vulcan, a Floating Machine Shop. Description from a lecture at the Naval War College, by W. M. McFarland ; also brief descriptions of repair ships of other nations. 2800 w. Am Mach—Aug. 18, 1898. No. 22117.

Gun-Fire.

Gun-Fire Analysis of the Santiago Sea Fight. The gun-fire analyzed for the Santiago sea fight by Lieut. B. W. Wells, with some of the causes to which the victory was due. 600 w. Eng News—Aug. 18, 1898. No. 22123.

Guns.

The Guns of Our Navy. Henry Hess. Information of interest. 800 w. Mach, N. Y.—Aug., 1898. No. 21887.

Man-of-War.

A War-Ship Community. W. J. Henderson. Illustrated description of life on a man-of-war. 4200 w. Scribner's Mag—Sept., 1898. No. 22176 C.

Monitor.

Ericsson's Coast-Defense Monitor "Nahant." Historical account with illustrated description of the vessel and its operation. 2200 w. Sci Am—Aug. 13, 1898. No. 22048.

Naval Reserve.

Reserves for the Royal Navy. Editorial on the steps being taken in England for strengthening that body. 2200 w. Engng—Aug. 5, 1898. No. 22070 A.

Naval Surgeons.

Naval Surgeons Ashore and Afloat. Francis R. Lee. An account of the efficient organized work of this department of service, the naval hospitals and ships. Ill. 2200 w. Chau—Sept., 1898. No. 22290 C.

Naval Vessels.

A Comparison of British and American Naval Vessels. Taken from the *N. Y. Tribune*, credited to the London *Mail.* An apparently fair and unprejudiced comparison, which concludes that English battleships are better than American, guns much better, projectiles and armor as good, but cruisers much worse. 1200 w. Eng News—Aug. 4, 1898. No. 21945.

Our Latest Naval Vessels. Particulars of the battleships, monitors, torpedo boats and destroyers authorized by congress. 3500 w. Marine Rev—Aug. 11, 1898. No. 22032.

Projectiles.

A Group of Navy Projectiles. Illustrates and describes the shells, of various dimensions, used by the U. S. navy. 800 w. Sci Am—Aug. 6, 1898. No. 21918.

Photographs of Air Waves Formed by Flying Projectiles. An article following in the main, a paper which Colonel von Obermayer contributed to the *Mittheilungen über Gegenstände des Artillerie- und Genie-Wesens.* Describes investigations in this field, giving illustrations. 3000 w. Engng—Aug. 12, 1898. No. 22156 A.

Repeating Pistol.

Borchardt Automatic Repeating Pistol. Illustrated description of the pistol and its action, with report of the trial by United States authorities. 1300 w. Engr, Lond—Aug. 19, 1898. No. 22409 A.

Russian Navy.

Lord Charles Beresford on the Russian Naval Programme. Gives a diagram showing the growth or decrease in numbers of British, French and Russian armor-clads during the last ten years. Calls attention to the increase in the Russian navy, and the prudence of British preparation for maintaining naval supremacy. 1700 w. Engr, Lond—July 29, 1898. No. 21968 A.

Santiago.

The Siege and Capture of Santiago. John A. Church. Gives an account of the transportation of the troops, landing, advance, the attack, and surrender. Ill. 5400 w. Am Rev of Revs—Aug., 1898. No. 21869 C.

Sea Power.

The Essential Elements of Modern Sea Power. Vice-Admiral P. H. Colomb, R. N. A review of the naval programme of England by one of the foremost authorities upon the subject, making important comparisons between England, France and Russia. 4500 w. Engineering Magazine—September, 1898. No. 22380 B.

Smokeless Powder.

An American Smokeless Powder. Frederick H. McGahie. Gives an account of the results obtained by the use of the Maxim-Schupphaus powder, with a brief sketch of the manufacturing process. 2800 w. Sci Am Sup—Aug. 27, 1898. No. 22238.

Squadrons.

Our Eastern Squadron and Its Commodore. Park Benjamin. Some particulars of the squadron under Camara, showing the weakness of the Spanish naval defenses, and also of the squadron the United States was preparing to send east under Watson, with remarks on the personal characteristics of the U. S. Commodore. 4500 w. Am Rev of Revs—Aug., 1898. No. 21870 C.

Torpedo Boats.

Electric Torpedo Boats. Charles T. Child. Brief account of the development of torpedo boats and the tactics prescribed at present for their use, with a statement of the advantages of electrical equipment, because of the absence of smoke, steam and noise, and increased effectiveness. 3000 w. Elec Wld—Aug. 6, 1898. No. 21921.

The Machinery of the New Torpedo Boats and Torpedo-Boat Destroyers. Describes the machinery of the 12 new torpedo boats and 19 torpedo-destroyers as given in the official circular to bidders. 1400 w. Eng News—Aug. 4, 1898. No. 21938.

War Lessons.

Engineering Lessons from the Hispano-American War. Hiram Stevens Maxim. Showing the necessity of the possession of engineering ability to operate modern fighting machinery, and maintaining that mechanical supremacy is the vital factor in military success. 2500 w. Engineering Magazine—September, 1898. No. 22381 B.

MINING AND METALLURGY.

COAL AND COKE.

Ammonia.

Ammonia and Its Sources. Bruno Terne. Discusses the gains from the products of coke-ovens, the system of coking that yields the best results, and other sources of ammonia. 4000 w. Jour Fr Inst—Aug., 1898. No. 21912 D.

See Municipal Engineering, Gas Supp y.

Anthracite.

The Anthracite Question. Editorial discussion of the troubles which beset this trade, outlining a plan for the conversion of the coal into gas and its transmission, as the use of gas for domestic purposes is continually increasing. 1400 w. Eng & Min Jour—Aug. 6, 1898. No. 21979.

Arkansas.

The Coal Measures of Arkansas. Charles R. Keyes, in the *Journal of Geology*, Chicago. Facts ascertained recently which make possible a comparison of the enormous thickness of the coal measures of this region, with the more northern districts. 2800 w. Col Guard—Aug. 5, 1898. No. 22066 A.

Carboniferous Rocks.

The Lower Carboniferous Rocks of England and Scotland. William Gunn. From the *Geological Magazine*. The object of the paper is to show the relation of the beds in England and Scotland. 2500 w. Col Guard—Aug. 19, 1898. No. 22400 A.

Coal Cleaning.

Combined Coal Screen and Disintegrator. Illustrates and describes an appliance for cleaning coal by a dry method. 1800 w. Col Guard—Aug. 5, 1898. No. 22065 A.

Coal Seams.

Some Notes on the Bord-and-Pillar System of Work. Attention is called to some details of bord-and-pillar working of importance where economy is needed and commercial success desired. 4400 w. Col Guard—July 29, 1898. Serial. 1st part. No. 21966 A.

Coal Storage.

The West Superior Coal-Storage Plant of the Lehigh Valley Coal Co. William R. Davis. Illustrates and describes a plant having several features of novelty and interest. 1600 w. Eng News—Aug. 18, 1898. No. 22120.

Coke Appliances.

The Automatic Manipulation of Coke. Gilbert Little. Read at meeting of North British Assn. of Gas Managers. Descriptive comments on some of the latest methods of conveying, elevating, screening, sorting and stacking coke. Ill. 1100 w. Gas Wld—Aug. 6, 1898. No. 22076 A.

Coke Industry.

Commercial and Technical Progress of the German Coke Industry. F. Simmersbach. Condensed translation from *Stahl und Eisen*. Information relating to the Ruhr district, the progress made, the ovens used, by products, &c. 2200 w. Am Mfr & Ir Wld—Aug. 12, 1898. No. 22084.

The Recent Development of the German Coke Industry. (Neue Ergebnisse der Deutschen Koksindustrie.) F. Simmersbach. A statistical paper, reviewing the production by districts, from 1890 to 1897, during which period an increase of 55 per cent. occurred. The Otto oven is illustrated and described. 5000 w. Stahl und Eisen—July 15, 1898. No. 22355 D.

Modern Systems of Coking. (Die Heutigen Koksöfensysteme.) A discussion of the various methods of coking with ovens intended to save the by-products; with especial reference to the Neinhaus oven. 4000 w. Glückauf—July 9, 1898. No. 22351 B.

Development of By-Product Coke Making. From advance sheets of the report on the "Manufacture of Coke in 1897," by Edward W. Parker of the U. S. Geological Survey. Discusses the change in methods, the change made in moving the industry from the mining regions to the centers of industrial activity, the use of gas for fuel, and related subjects. 3500 w. Am Mfr & Ir Wld—Aug. 26, 1898. No. 22282.

Deposits.

Indian Coal Deposits. Perry F. Nursey. Articles giving information of the important deposits in India, the methods of working and labor conditions. 2500 w. Ind & Ir—July 29, 1898. Serial. 2 parts. No. 21963 each A.

France.

Results of Recent Borings for Coal in the North of France. (Resultats des Récents Sondages pous la Recherche de la Houille dans le Nord de la France.) J. Gosselet. The results show only coal measures of inferior quality, probably prolongations of the Franco-Belgian basin. 1200 w. Comptes Rendus—July 18, 1898. No. 22345 D.

India.

The Coal Supply of India. Wyndham R. Dunstan. An exhaustive report on the occurrence, distribution, mode of working, production, imports and exports, chemical examination and results. 4500 w. Col Guard—July 22, 1898. No. 21830 A.

Isle of Arran.

The Carboniferous Rocks of the Isle of Arran. From the annual report of the Geological Survey, 1897. Records important new discoveries in the geology of this island in the Firth of Clyde. 4000 w. Col Guard—Aug. 5, 1898. No. 22064 A.

Lignite.

The Calorific Value and Moisture of Lignite. (Heizwert und Wassergehalt der Braunkohlen.) L. C. Wolff. A comparative study of the various German lignites or "brown coals," with computations of the calorific values and tables of the percentages of contained moisture. 5000 w. Zeitschr d Ver Deutscher Ing—July 9, 1898. No. 22301 D.

Royalty.

Colliery Royalty Accounts and Depreciation. George Johnson. Explains the meaning of the term "royalty," and gives an illustration. 2500 w. Col Guard—Aug 12, 1898. No. 22162 A.

Small Mines.

Small Coal Mines. J. T. Beard. How they may be economically worked where the seams are thin and shallow and the field limited. Methods pertaining to their location, and the sinking and timbering of shafts, slopes, drifts, &c., in small operations which do not warrant a large outlay of capital. 4500 w. Mines & Min—Aug., 1898. No. 21947 C.

South Africa.

The Transvaal Coalfield. William Piele. Abstract of paper read before the North of England Inst. of Min. & Mech. Engs. Describes the deposits, quality, and some points relating to the mining. 1500 w. Ir & Coal Trds Rev—Aug. 12, 1898. No. 22168 A.

South America.

The Coal Trade and Lignite Deposits of Northern South America. Francis C. Nicholas. Statements showing what these lignite deposits are and their future possibilities, with brief reference to the future needs of the country and the opportunity for trade. 1800 w. Eng & Min Jour—Aug. 20, 1898. No. 22144.

South Wales.

The Re-Survey of the South Wales Coalfield. A. Strahan. An account of the progress made during the last year by the officers of the Geological Survey in the re-survey of the South Wales coalfield, as given in the annual report. 5500 w. Col Guard—July 22, 1898. No. 21834 A.

COPPER.

Copper Mine.

One of the World's Richest Mines. Some interesting information relating to the Calumet and Hecla mine in northern Michigan. 1200 w. Min & Sci Pr—Aug. 20, 1898. No. 22244.

GOLD AND SILVER.

Alaska.

As Seen by an Old Prospector. "Alex. Quartz." An account of the promising fields near St. Michaels, with some reference to the Klondike, and to other districts. 4500 w. Min & Sci Pr—Aug. 13, 1898. No. 22130.

Arizona.

Notes from Mohave County, Arizona. Theo. B. Comstock. Calling attention to this district as favorable for mining investment, and briefly outlining some of the mining enterprises of the region. 2800 w. Eng & Min Jour—Aug. 6, 1898. No. 21980.

Assay.

The Position of the Assay Department in Mining Economics. Franklin White. The necessity for correct assays and the work of the competent assayer. 1600 w. Jour of Chem & Met Soc of S. Africa—June, 1898. No. 22005 E.

Auriferous Lodes.

The Genesis of Certain Auriferous Lodes. Continued discussion of paper by Dr. John R. Don, presented at the Chicago meeting, Feb., 1897. 1500 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22263 D.

Australia.

Australasian Gold Mining. Dr. Karl Schmeisser. From *Die Goldfelder Australasiens*. Discusses the present and future outlook, drawing favorable conclusions. 1500 w. Aust Min Stand—July 21, 1898. No. 22425 B.

British Columbia.

Lillooet Mining District. W. M. Brewer. An account of this district, the mines being worked, the formation, &c. 2000 w. Eng & Min Jour —Aug. 13, 1898. No. 22088.

Broken Hill.

Some Mining and Metallurgical Developments at Broken Hill. T. J. Greenway. An illustrated account of the mining developments in New South Wales, describing the treatment of the ores. 1800 w. Eng & Min Jour—Aug. 27, 1898. No. 22257.

The Treatment of Broken Hill Sulphide Ores by Wet-Extraction Processes, and the Electrolytic Deposition of Zinc Edgar A. Ashcroft. Abstract of paper read before the British Inst. of Mining & Metallurgy. An account of some novel metallurgical work in Australia which, though a commercial failure, is of interest. 7000 w. Elect'n, Lond—Aug. 19, 1898. No. 22419 A.

Colombia, S. A.

Mining Districts of Colombia. Communications in discussion of the paper by Henry G. Granger and Edward R. Treville. 1800 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22264 D.

Notes on the Mines of the Frontino and Bolivia Company, Colombia, S. A. Spencer Cragoe. Describes the geographical formation and general features of the property, giving an account of mining costs, labor and transport, reduction, &c. 3600 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22262 D.

Concentration.

Advanced Methods of Concentration. J. W. Neill. An extempore address at the Salt Lake session of the International Mining Congress. A discussion of wet concentration, matte smelting, and other processes. 4200 w. Min & Sci Pr—July 30, 1898. No 21930.

Cripple Creek.

A Trip Around Cripple Creek. Arthur Lakes. Notes on the changes and improvements which have been made there within a short time, with illustrations. 1800 w. Mines & Min—Aug., 1898. No. 21949 C.

Cyanide.

Analyses of Cyanide-Mill Solutions. W. J. Sharwood. Gives analyses made in the laboratory of the Univ. of California, describing methods. 800 w. Eng & Min Jour—Aug. 20, 1898. No. 22142.

Deposits.

The Auriferous Deposits of Siberia. René de Batz. Gives some of the reasons for the slow development of these gold fields, describes the general geology of the Siberian placers, the economic conditions, methods of working, &c. Map. 5000 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22266 D.

Dredging.

Hydraulic Dredging. Description, with illustrations, of the working of the Yackandandah leases in Australia, by dredging for gold. 2500 w. Aust Min Stand—June 30, 1898. No. 21880 B.

Kootenay.

A Glimpse at Kootenay and Its Wonders. William Bleasdell Cameron. Illustrates and describes the railroad, scenery, points along the route, the mines, ores, &c. 2000 w. Loc Engng —Aug., 1898. No. 21883 C.

Milling.

Gold Milling. Gilbert E. Bailey. Preliminary work in selecting the processes and machinery suitable for a given ore. Observations on testing plants; classification of processes; sulphurets; ore stamping; situation, construction and arrangement of mills, &c. 3000 w. Mines & Min—Aug., 1898. Serial. 1st part. No. 21952 C.

Nicaragua.

Gold in Nicaragua. C. T. Mixer. Brief account of a region between the 11th and 15th degrees of north latitude, with mention of a few of the properties which have been worked. Ill. 1500 w. Eng & Min Jour—July 30, 1898. No. 21814.

Oregon.

Gold Mining in Oregon. R. W. Barrell. A description of the development of the mines and the peculiarities of the ores and veins of the eastern mining region of the state, together with an account of climate and topography and the methods of working the mines. 5600 w. Mines & Min—Aug., 1898. No. 21950 C.

Prospecting.

Gold Prospecting in New Guinea. John Plummer. Brief account of conditions and the vicissitudes accompanying the work. 700 w. Eng & Min Jour—Aug. 20, 1898. No. 22143.

River Channels.

Gold in Ancient California River Channels. Extracts from the account of the Forest Hill Divide by Ross E. Brown, with comments and illustrations. 3500 w. Min & Sci Pr—July 30, 1898. No. 21931.

Sea-Water Gold.

The Electrolytic Marine-Salts Company. History of the company, with editorial comment, showing how readily the American public are humbugged. 2400 w. Eng & Min Jour—July 30, 1898. No. 21813.

Silver-Lead.

Experiments in the Sampling of Silver-Lead Bullion. G. M. Roberts. Report of interesting experiments made in sampling the silver-lead bullion obtained from the water-jacket smelting-furnace at the Proprietary Mines, Broken Hill, N. S. W., for the purpose of ascertaining the relative accuracy of the methods then in use. 3000 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22261 D.

Smelting.

Recent Advances in Silver-Lead Smelting. R. H. Terhune. Read at the Salt Lake session of the International Mining Congress. Reviews the improvements in recent years in silver-lead smelting. 2800 w. Min & Sci Pr—Aug. 6, 1898. No. 22040.

The Lang Smelting Furnace. Illustrates and describes a form of furnace recently patented. 1000 w. Eng & Min Jour—Aug. 6, 1898. No. 21981.

IRON AND STEEL.

Arctic Circle.

The Iron Ores of the Arctic Circle. Perry F. Nursey. In connection with the meeting of the Iron & Steel Inst., at Stockholm, an excursion is to be made to the arctic mines. Information concerning these deposits is given. 1800 w. Ind & Ir—Aug. 19, 1898. Serial. 1st part. No. 22410 A.

Blowing Engines.

See Mechanical Engineering, Engines.

Filling.

Note on the Forms Assumed by the Charge in the Blast-Furnace, as Affected by Various Methods of Filling. Frank Firmstone. Information accumulated from careful measurements in the furnace, afterwards recorded for comparison in drawings. Most of the measurements were made at Glendon Iron Works where the fuel used was anthracite, and the ore mixtures about ¾ New Jersey magnetic ores and ¼ brown ores. 3500 w. Trans Am Inst of Min Engs—Aug., 1898. No. 22267 D.

Furnace.

See Electrical Engineering, Electro-chemistry.

Iron Manufacturing.

Iron Manufacturing at Marquette. Extracts from a report of John Birkinbine, made for J. M. Longyear. A masterly discussion of the advantages and disadvantages of Marquette for iron and steel manufacture. 10000 w. Ir Age—Aug. 4, 1898. No. 21909.

Ores.

American as Compared with British Iron Ores. Walter J. May. Extracts from the Report on the Mesabi Iron Range in Minnesota, by J. Edward Spurr; the ores are compared with English ores; methods of working are discussed, and related matters of interest treated. 2500 w. Prac Eng—Aug. 5, 1898. No. 22053 A.

Foreign Iron Ores at the Disposal of European Works. Circumstances relating largely to Great Britain's supply. The ores of Spain and Sweden are specially discussed. 2000 w. Ir Age—Aug. 18, 1898. No. 22106.

High-Grade Iron Ores. Walter J. May. Discusses the necessity of dealing with the deposits of low-grade ores and concentrating them at the mines to a high metallic value. 900 w. Col Guard—Aug. 12, 1898. No. 22164 A.

Steel Constituents.

The Constitution of Steel Considered as an Alloy of Iron and Carbon. Albert Sauveur. Briefly outlines the laws which govern frozen saline solutions, and showing how they help to account for the structure of metallic alloys. Ill. 6000 w. Tech Quar—June, 1898. No. 21817 F.

Swedish Iron.

Strength Tests of Swedish Iron and Steel. Interesting tests published by the "Järnkontoret," giving table showing the percentages of carbon which have been proved suitable for various applications, and other information. 900 w. Engng—Aug. 19, 1898. No. 22295 A.

MINING.

Boreholes.

Tubed Cylinder Stemming for Boreholes. W. Wilson Barnes. Illustrates and describes methods of using these cylinders, and the success and advantages. 1200 w. Col Guard—July 22, 1898. No. 21832. A

Explosives.

Experiments with Safety Explosives. P. Hess. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Gives the code of regulations insuring uniformity in the methods of testieg with a summary of the results obtained. 1200 w. Col Guard—Aug. 5, 1898. No. 22067 A.

New Order as to the Use of Explosives in Coal Mines. A new order as to the use of explosives in British mines in substitution or the order dated Feb. 4, 1898. 900 w. Ir & Coal Trds Rev—July 22, 1898. No. 21849 A.

Firedamp.

Firedamp in Its Relation to Meteorology. Ernest Van den Broeck. From a communication to the Société Belge de Geologie de Paléontologie et d'Hydrologie. Remarks on the limited success in solving the problem of firedamp, and a project for making magnetic and endogenous observations to investigate the connection between the disengagement of underground gases and aërial storms. 2200 w. Col Guard—Aug. 12, 1898. No. 22163 A.

Mining Law.

The Providence-Champion Decision. R. W. Raymond. Discusses the parts of the case having a general application, and the decision rendered. 1600 w. Eng & Min Jour—Aug. 20, 1898. No. 22141.

Pit-Props.

The Strength of Pit-Props. H. Louis, in London *Mining Journal.* Records experiments made involving about 170 separate tests. 2200 w. N. Z. Mines Rec—July 16, 1898. No. 22424 B.

Pump.

See Electrical Engineering, Power.

Rescue Appliances.

New Rescue-Appliances and Their Use in Mines. M. L. Denoël, in the *Annales des Mines de Belgique.* Discusses the appliances, giving some reasons why they have not come into general use. 1800 w. Col Guard—Aug. 19, 1898. No. 22296 A.

Shaft Sinking.

Deepening and Strengthening the Oskar Shaft No. 1. at Petrzkowitz, Preussen. (Abteufen und Ausmauerung des Oskar-Schachtes Nr. I bei Petrzkowitz in Preussen.) Describing the operation of sinking a shaft over 650 feet including lining with masonry. Valuable data are given as to time and cost in various strata. 5000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 30, 1898. No. 22349 B.

Sinking and Lining a Shaft at a Prussian Colliery. Jaroslav Jicinsky, *Oesterreichische Zeitschrift für Berg und Hüttenwesen.* Describes the sinking of the new Oskar shaft, 197 m. in depth. 1200 w. Col Guard—Aug. 12, 1898. No. 22165 A.

Underground Pumping.

Underground Steam Appliances and Temperature of the Strata. Robert Martin. Abstract of a paper read before the Mining Inst. of Scotland. Illustrates and describes the steam pumping system at Niddrie collieries. 1200 w. Col Guard—Aug. 19, 1898. No. 22297 A.

Winding Engines.

See Mechanical Engineering, Engines.

MISCELLANY.

Aluminum.

Aluminum Manufacture, with Description of the Rolling Mills and Foundry at Milton, Staffordshire. E. Ristori. Read before the Inst. of Mech. Engs. at Derby, England. Description and plan of the works where aluminum is melted and refined until it attains a purity of 99.6 per cent. The manner of working, the alloys, and uses, are considered. Also discussion. 7500 w. Engng—July 29, 1898. No. 21961 A.

The Present Status of the Aluminum Industry. (Der Heutige Stand der Aluminium Industrie.) Dr. B. Neumann. A review of the development of the industries since the introduction of the Deville process; with data as to the production of the American, Swiss, and French establishments at the present time by electrical methods. 2500 w. Glückauf—July 30, 1 No. 22354 B.

Bearing Metals.

The Microstructure of Bearing Metals. Guilliam H. Clamer. An interesting study of the structure and composition of the various bearing metals, especially those used in railroad service, has led to the conclusion that an alloy of the proper proportions of copper, tin and lead seems best suited for the purpose. Discussion. Ill. 5500 w. Jour Fr Inst—Aug., 1898. No. 21913 D.

Chinese Mines.

Chinese Salt and Gas Mines. An interesting account of the manner of working these mines, which have been uninteruptedly worked for over twenty centuries. 1500 w. Engr, Lond—Aug. 12, 1898. No. 21922 A.

Clays.

The Clays and Clay Industry of Massachusetts. Charles L. Whittle. Gives information of the workable beds of the state, and of the advancement of this industry. 2100 w. Eng & Min Jour—Aug. 27, 1898. No. 22256.

Corundum.

The Corundum Lands of Ontario. An account of the discovery and occurrence, with the conditions and regulations proposed by the Director of the Bureau of Mines to be adopted and followed in connection with the disposition of corundum-bearing lands. 3000 w. Can Min Rev—July, 1898. No. 21874 B.

Exposition.

The Trans-Mississippi International Exposition. A description of the mineral exhibits from the different states and territories represented in the mining building. 2500 w. Mines & Min—Aug., 1898. No. 21948 C.

Fuel.

A Popular Study of the Mineral Fuels of the World. (Volkswirthschaftliche Studie über die Mineralischen Brennstoffe der Erde.) Prof. F. Kupelureser. An exhaustive compilation, with valuable comments, the figures being tabulated for all countries from 1870 to 1896. Three articles. 15000 w. Zeitschr d Oesterr Ing u Arch Ver—July 8, 15, 22, 1898. No. 22316 each B.

New Methods.

Recent Improvements in Metallurgical Methods. (Neuerungen im Metallhüttenwesen.) Dr. Dürre. Brief descriptions of improvements in the metallurgy of aluminum, antimony, arsenic, lead, silver, gold, copper, nickel, zinc, and tin. 4500 w. Glückauf—July 16, 1898. No. 22352 B.

Petroleum.

The Baku Petroleum District of Russia. David A. Louis. A fully illustrated account of the Russian oil fields as seen at the time of the visit of the International Geological Congress. 3500 w. Engineering Magazine—September, 1898. No. 22388 B.

The Russian Petroleum Industry in 1897. (Die Russische Erdölindustrie im Jahre 1897.) A review of the progress of the Baku oil fields during the past year; monthly comparisons being made with the years 1895 and 1896. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 23, 1898. No. 22350 B.

Pit Gases.

Apparatus for Estimating Marsh Gas and Carbon Dioxide in Pit Gases. R. Jeller. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* An illustrated description of apparatus suitable for the requirements of practice, but not intended for use where the proportion of combustible gases gives rise to an explosive mixture. 1500 w. Col Guard—Aug. 5, 1898. No. 22063 A.

Transvaal.

The Mineral Resources of the Middelburg District (Transvaal). Herbert Lloyd. Read before the Manchester Geological Society. Describes the geology of the region, gives information relating to the coal deposits, and the rich mineralized districts. 1700 w. Col Guard—Aug. 19, 1898. No. 22298 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Accidents.

Accidents with Gas. William Paul Gerhard. Narrates various accidents and emphasizes the dangers arising from leakage. 2700 w. Am Arch—Aug. 6, 1898. No. 22000.

Acetylene.

The Criterion Automatic Acetylene House Generator. Illustrates and describes two styles of acetylene-gas generators, especially intended for lighting single dwelling houses, country seats and out buildings, small manufacturing plants, &c. 700 w. Sci Am—Aug. 6, 1898. No. 21917.

The Utilization of Acetylene. A review of the advantages and limitations of acetylene and a discussion of the position the calcium-carbide industry may hope to gain. 2500 w. Engr, Lond—Aug. 19, 1898. No. 22403 A.

Ammonia.

A Noteworthy Curiosity from the U. S. Patent Office. Frederick Egner. An explanation of what is known as the Fogarty process for producing gas and ammonia, by which the gas is merely a by-product made without cost. 2000 w. Am Gas Lgt Jour—Aug. 8, 1898. No. 21998.

See Mining and Metallurgy, Coke.

Calcium Carbide.

Development of the Carbide of Calcium Industry. Gives facts of scientific interest in connection with this product, its history, and the commercial importance of the industry. 4000 w. Sci Am Sup—Aug. 13, 1898. No. 22049.

The Manufacture of Calcium Carbide. Abstract of a paper read by M. Nicolai, at a meeting of the Polytechnical Society, at Berlin. Discusses the raw materials, important points in the manufacture, transportation, &c. 1600 w. Am Mfr & Ir Wld—Aug. 26, 1898. No. 22283.

The New Plant of the Union Carbide Company at Sault Ste. Marie, Mich. Illustrated description of the new equipment whose initial output is to be ten times that of Niagara, with capacity for extension as the demand increases. 1800 w. Elec Wld—Aug. 6, 1898. No. 21920.

Competition.

Gas in Competition with Electricity by Water Power. A. Gutsch. Read at meeting of the Pacific Coast Gas Assn. A statement of facts as they are found at Fresno, Cal. Also discussion. 3600 w. Am Gas Lgt Jour—Aug. 15, 1898. No. 22082.

Cowan System.

The "Cowan Pressure-System." J. Hepworth. Read at meeting of North British Assn. of Gas Managers. Notes on the object of this system, with short description of the apparatus. Discussion. 3800 w. Gas Wld—Aug. 6, 1898. No. 22075 A.

Explosions.

Note on Further Studies into the Phenomena of Gas Explosions. W. H. Birchmore. Describes experiments made to investigate the apparent antithesis between the wrecking and incendiary power of an explosion. 2400 w. Am Gas Lgt Jour—Aug. 1, 1898. No. 21879.

Lubrication.

Lubrication in the Gas Business. O. M. Gregory. Read at meeting of the Pacific Coast Gas Assn. Brief talk on the use of lubricants and kinds best suited to the gas business. 1800 w. Am Gas Lgt Jour—Aug. 15, 1898. No. 22083.

Mantles.

Thread Foundation for Incandescent Mantles. Illustrates a device for producing more durable and effective mantles. 500 w. Bos Jour of Com—Aug. 20, 1898. No. 22185.

Meters.

Experiences with Prepayment Meters. A. Wilson. Read at meeting of North British Assn. of Gas Managers. An account of the experiences in Perth, Scotland, where over 1100 are in use. Discussion. 2000 w. Gas Wld—Aug. 6, 1898. No. 22074 A.

My Experience with Prepayment Meters. R. Ross. Read before the North of Ireland Assn. of Gas Managers. Gives an account of the difficulties met, but reports satisfactory results. Discussion. 2800 w. Gas Wld—Aug. 13, 1898. No. 22170 A.

Oil Heater.

An Efficient Oil Heater. E. C. Jones. Read before the Pacific Coast Gas Assn. Illustrates and describes a heater which has successfully heated both crude oil and distillates for two 12-foot generators, making 1,000,000 feet of gas each per 24 hours, but running alternately. Discussion. 4800 w. Am Gas Lgt Jour—Aug. 22, 1898. No. 22198.

Purifying.

The Purifying of Coal Gas. Stephen Carpenter. Describes process of purification found more convenient and economical than any other in which lime is employed. 2000 w. Jour of Gas Lgt—Aug. 9, 1898. No. 22131 A.

Retorts.

Retort Settings and Practical Results Obtained. William Ewing. Read at meeting of North British Assn. of Gas Managers. Describes the works of the Hamilton Corporation (Scotland), the difficulties and means of overcoming them. Discussion. Ill. 5000 w. Gas Wd—July 30, 1898. No. 22012 A.

Self-Lighters.

Recent Progress in Self-Lighters for Incandescent Lamps. M. Syssoyeff. Read before the French Society. A review of the attempts made to solve this problem and report of the results obtained in lighting by chemical reaction. 2300 w. Gas Wld—July 23, 1898. No. 21864 A.

SEWERAGE.

Drainage.

See Architecture and Building, Plumbing.

Norwich, Eng.

Norwich Sewerage Works. Illustrates and describes a system that has been obliged to conquer many difficulties. 1500 w. Engr, Lond—July 22, 1898. No. 21841 A.

River Pollution.

Pollution of Rivers from an Engineer's Point of View. Reginald E. Middleton. Discusses the various sources of pollution and the means of purification. 2500 w. Jour of the San Inst—April, 1898. No. 21855 G.

Rivers-Pollution Standards. W. Naylor. Discusses standards suggested, and their applicability, urging the necessity of a uniform standard and method of analysis. Discussion. 5400 w. Jour of San Inst—April, 1898. No. 21857 G.

Sewage Conveyance.

The Old and the New. Alexander Dalrymple. Read at the opening of the tenth session of the Glasgow and West of Scotland Technical College. Deals with fittings for bathrooms. 3000 w. Dom Engng—Aug., 1898. Serial. 1st part. No. 22101 C.

Sewage Disposal.

Bacterial Processes of Sewage Purification. Rudolph Hering. A review of the latest developments in sewage purification by bacterial processes, with descriptions and illustrations of the works at Exeter, Sutton, and Yeovil. 4500 w. Engineering Magazine—September, 1898. No. 22386 B.

London Sewage Disposal. James H. Fuertes. Description of methods and results at two large chemical-treatment plants. 1200 w. Eng Rec—Aug. 27, 1898. Serial. 1st part. No. 22276.

Massachusetts Experiments on the Purification of Fresh, Stale, and Septic Sewage. H. W. Clark. A brief review of the work at the Lawrence experiment station, and results of investigations recently made. 5800 w. Eng News—Aug. 4, 1898. No. 21944.

The Disposal of Sewage in Tidal Estuaries. G. Sims Woodhead. Points out the different conditions in some large tidal rivers, and discusses what is necessary in order that purification may take place. Also discussion. 3500 w. Jour of San Inst—April, 1898. No. 21854 G.

The Purification of Sewage by the Ferozone Polarite System. John W. Alvord. Description of the original works at Acton, Eng., where this chemical system is in use, with account of the operation and efficiency. Discussion. 7500 w. Ill. Soc of Engs & Surv—1898. No. 22210 D.

Sewers.

Injuries to Sewers by Roots. Description of the construction of pipe sewers in Washington to prevent this trouble. 2500 w. Eng Rec—Aug. 20, 1898. No. 22193.

The New Sewer System of Chicago. A brief account of the extensive work in progress and its cost, with a statement of the conditions which led to the undertaking. Ill. 2000 w. Engr, Lond—July 22, 1898. No. 21839 A.

Trade Waste.

Conditions for the Preliminary Treatment of Trade-Waste Water before its Admission into Public Sewers. H. Maclean Wilson. A statement of the conditions that should be required before such liquids are received into the public sewers. Discussion. 3500 w. Jour of the San Inst—April, 1898. No. 21856 G.

STREETS AND PAVEMENTS.

Asphalt.

Minor Repairs to Asphalt Pavements. F. E. Puffer. The object of the article is to show how minor repairs to asphalt pavements may be made in an economical and substantial manner without the use of a large asphalt plant. 500 w. Munic Engng—Aug., 1898. No. 21867 C.

Wood Pavements.

The Sanitary Aspects of Wood Pavements. Charles Mason. Brief reference to the kinds of wood employed, their treatment and method of laying, with discussion of the sanitary conditions, showing that the writer considers complaints of this pavement to be due to improper methods of laying and maintaining, with faulty systems of scavenging. 1500 w. Jour of San Inst—April, 1898. No. 21860 G.

WATER SUPPLY.

Distribution.

Test of a Pipe Distribution System. James S. Haring. Description of method of detecting defective pipes, valves, and hydrants, with an account of unusual failures of valves. 1700 w. Eng Rec—July 30, 1898. No. 21809.

Domestic Supplies.

The Purification of Domestic Water Supplies. H. T. Y. Outlines a plan to heat water to a temperature of 230° Fahr. for seven minutes under pressure, before it enters the mains for distribution. 1000 w. San Rec—July 22, 1898. No. 21824 A.

Early Plants.

Early Water-Works Plants. Extracts from a paper by William R. Hill presented at the Buffalo meeting of the Am. Water-Works Assn. Interesting historical review of skill in obtaining water. 1600 w. Fire & Water—Aug. 6, 1898. Serial. 2 parts. No. 21929.

Filtration.

The Filtration of Water in Germany. M. L. Holman. Describes German practice in filtration, giving only those features which pertain directly to construction and operation. Discussion. Ill. 10500 w. Jour Assn of Engng Soc's—July, 1898. No. 22217 C.

The Somersworth, N. H., Sand Filters. Illustrated description of covered sand-filters of half-an-acre effective area. 1100 w. Eng Rec—Aug. 27, 1898. No. 22273.

Glasgow.

Glasgow Water Works. James H. Fuertes.

An account of the water supply and the construction of the new reservoir, work on which has been in progress for 13 years, with the general plan of the works. 1200 w. Eng Rec—Aug. 6, 1898. No. 21988.

Intakes.

The Intakes of the Great Lakes. Thomas W. Barrally. From a paper read before the Mich. Engng. Soc. Describes various intakes on the Great Lakes and the difficulties met with, favoring the submerged type. 1800 w. Ry & Engng Rev—Aug. 6, 1898. No. 21992.

The New Water-Works Intake Tunnel for Cleveland, Ohio. A description, with illustrations, of the new tunnel and accessories, with brief reference to the old works. This is supposed to be the longest water-works intake tunnel yet attempted. 6700 w. Eng News—Aug. 11, 1898. No. 22045.

Legal Decision.

Two Recent Legal Decisions Concerning the Sale of Water. Reviews decisions in Kansas and California affecting the business of water companies. 800 w. Eng Rec—Aug. 13, 1898. No. 22091.

Meters.

Calibration of a Water Meter. William D. Ennis. Describes a form of apparatus, built by the writer for experimenting with meters and an account of experiments made. 1200 w. Stevens Ind—July, 1898. No. 21853 D.

Montauk Point.

The Water at Montauk Point Camp. Brief account of the state of the water supply, reporting the quantity plentiful at present, but some doubts are expressed of its permanence. 800 w. Fire & Water—Aug. 20, 1898. No. 22148.

Pollution.

The Local Government Board and the Protection of Water Supplies from Pollution. Percy Griffith. Deals with the clauses bearing on this matter, which the Board endeavored recently to introduce into Private Bills which were before the Houses of Parliament, summing the actual condition of affairs at the present time. 3400 w. Jour of Gas Lgt—Aug. 9, 1898. Serial. 1st part. No. 22132 A.

The Prevention of the Pollution of Water Supplies. Review of decision of New York Supreme Court permitting acquisition of land bordering reservoirs to prevent pollution. 1000 w. Eng Rec—Aug. 20, 1898. No. 22189.

Portland, Ore.

Portland's Perfect Water System. Brief account of the receipts from the municipal plant, with description. 800 w. Fire & Water—Aug. 27, 1898. No. 22288.

Pump House.

New Pump-House at Richmond, Va. Illustrated description of this recent improvement, and the system generally. 900 w. Fire & Water—Aug. 20, 1898. No. 22147.

Pumping.

Deep-Well Pumping. E. E. Johnson. Considers the subject of deep-well water-supply, and various types of pumps, with illustrated description of a continuous-flow deep-well pump, giving tests of plants where it is used. Discussion. 9000 w. Ill Soc of Engs & Surv—1898. No. 22211 D.

Pure Water.

Chemistry of Water Supply. A. W. Palmer. From a sanitary standpoint water which may continuously be used for drinking without deleterious effects is regarded as pure. An explanation of data obtained by analysis is given. Discussion. 7500 w. Ill Soc of Engs & Surveyors—1898. No 22209 D.

Purification.

Bacterial Reduction by Storage. Review of important investigations showing that the bacterial purification of the river-water supplies of London depends largely on storage. 2000 w. Eng Rec—Aug. 15, 1898. No. 22094.

Purification of Water for Barracks, Prisons, and other Institutions. J. Lane Notter. Discusses various methods of filtration, and other means of rendering water sterile. Discussion. 8500 w. Jour of San Inst—July, 1898. No. 21861 G.

Rates.

The Equity of the Detroit Water Rates. Reprint of decision of Michigan Supreme Court, upholding the right of the city's commissioners to collect the rates in force in 1890. A unique case. 3300 w. Eng Rec—Aug. 27, 1898. No. 22274.

Water Rates in Milwaukee. Editorial on objections to charging a uniform rate for large and small supplies. 1200 w. Eng Rec—July 30, 1898. No. 21805.

Reservoirs.

Compensating Reservoirs for Gravity Water Supplies in Lieu of Compensation for Riparian Rights and its Legal Aspects. Stephen E. Babcock. Read at the convention of the Am. Water-Works Assn. Discusses the ownership of excess flow of water, showing that without infringing on the rights of owners of land, this may be retained and used for water supply. 4000 w. Fire & Water—Aug. 20, 1898. No. 22146.

Standpipe.

Racine's Standpipe and Its Brick Casing. Describes this standpipe and its location, explaining the reasons for encasing it, and giving the specifications for the work. Ill. 3000 w. Fire & Water—Aug. 27, 1898. No. 22287.

State Supervision.

Proposed State Supervision of Water Supply and Sewage Disposal. Jacob A. Harmon. A brief review of work being accomplished under supervision of the Boards of Health of states where authority exists. Discussion. 8000 w. Ill Soc of Engs & Surv—1898. No. 22214 D.

Supply.

Furnishing Water. William Himrod. Read at the Buffalo meeting of the Am. Water Works Assn. Some of the experiences of the water commissioners with their customers, giving an account of system of conducting the water business in Erie, Penna. 3300 w. Fire & Water—Aug. 6, 1898. No. 21928.

Waste.

Water-Supply Waste in India. The difficulties arising from an attempt to manage an alien people in the same manner that obtains among those whose education and conditions are very different. Considers the principle that should be followed in supplying water to consumers. 1100 w. Ind Engng—July 23, 1898. No. 22220 D.

Water Pollution.

Water-Borne Typhoid Fever. Christopher Childs. A paper introducing a discussion of this subject, and chiefly considering the means by which this pollution may be prevented. Discussion follows. 9500 w. Jour of San Inst—July, 1898. No. 21862 G.

Watersheds.

The Desirability of Making Watershed Areas and Sanitary Districts Coterminous. R. E. Middleton. Shows that the changed conditions of life, especially in England, have greatly increased the tendency to pollute rivers; that the growth of cities and towns has made the water supply more limited, yet increased the demand; and discusses the policy necessary if the water supply is to be efficiently safe-guarded. General discussion. 7500 w. Jour of San Inst—July, 1898. No. 21863 G.

Water-Works.

Anabaena. Report of investigation of the source of the odors imparted by anabaena to water supplies. 500 w. Eng Rec—Aug. 27, 1898. No. 22270.

Wells.

What Is a Test of a Well? A discussion of legal difficulties due to faulty specifications; the case of Bennett v. Edison Electric Illuminating Co. 900 w. Eng Rec—Aug. 6, 1898. No. 21984.

MISCELLANY.

Detroit.

Detroit: An Interesting City. A finely-illustrated article describing the interesting features of the city and its municipal affairs. 3800 w. Munic Engng—Aug., 1898. No. 21866 C.

Garbage.

Garbage Disposal at Detroit. An interesting description of the reduction process taken from the annual report of Dr. Walter Kempster of Milwaukee, a delegation of officials having visited the plant. 900 w. Eng Rec—Aug. 6, 1898. No. 21986.

The Barren Island Garbage-Disposal Plant. Olin H. Landreth. Report on the remodeled plant reducing the garbage of Manhattan and Brooklyn, New York City. 1500 w. Eng Rec—Aug. 27, 1898. No. 22277.

Refuse.

Refuse Disposal in Edinburgh. Editorial review of the methods and expense in this city, showing that this problem must be solved for each city independently. 800 w. Eng Rec—Aug. 6, 1898. No. 21983.

The Horsfall Destructor. Illustrates and describes the destructors at Bradford, Eng., which have several improvements of interest. 2500 w. Engng—Aug. 12, 1898. No. 22158 A.

Sanitation.

The Outcome of Sanitation. Louis C. Parkes. A record of the progress during the reign of Queen Victoria. 6500 w. Jour of San Inst—April, 1898. No. 21890 G.

See Architecture and Building, Plumbing.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Three Months' Railway Accidents. From the British Board of Trade Returns of Accidents and Casualties. Shows a decrease in the numbers of killed and injured as compared with last year. 900 w. Transport—Aug. 19, 1898. No. 22414 A.

Live Stock.

The Transit of Live Stock on Railways. Discusses the poor accommodations for the transportation of animals in Great Britain and Ireland, with the recommendations of the Departmental Committee of the Board of Agriculture. 1500 w. Transport—July 22, 1898. No. 21821 A.

Private Lines.

The Relation of Private Car Lines to the Railroads. G. W. Showers. Read at meeting of the Car Foremen's Assn. of Chicago. Reviews the early conditions of railroading and the work of the private car lines. 3800 w. Ry Mas Mech—Aug., 1898. No. 21997.

Train Service.

The Summer Train Improvements. Editorial comment on the train service of Great Britain. 2000 w. Engng—Aug. 19, 1898. No. 22292 A.

Train Speeds.

A New American Railway Record. Charles Rous-Marten. English comments on the speed attained by the fast trains between Philadelphia and Atlantic City. 800 w. Engr, Lond—Aug. 5, 1898. No. 22061 A.

On the Fastest Train in the World. A. S. Describes a ride on the train that runs from Camden to Atlantic City, a distance of 55.5 miles in 50 minutes. 1200 w. Loc Engng—Aug., 1898. No. 21882 C.

Record-Breaking Railway Runs. List of 125 of the most notable runs made in Great Britain and America, with remarks. 1800 w. Ry Age—July 29, 1898. No. 21872.

FINANCIAL.

American Railroads.

The Country's Railroads. Some remarks on the statistics for the year ending June 30, 1897, which show how the railroads suffered from the effects of the disturbance of credit and shrinkage of business during that trying year. 800 w. Bradstreet's—Aug. 27, 1898. No. 22246.

Earnings.

July Railroad Earnings Show Small Gains. A report of the July earnings, with comparison of corresponding mileage for previous year. 2500 w. Bradstreet's—Aug. 13, 1898. No. 22050.

Net Railway Earnings Well Maintained. Reports the first half of the present year as highly satisfactory and gives comparative tables. 1200 w. Bradstreet's—Aug. 20, 1898. No. 22137.

MOTIVE POWER AND EQUIPMENT.

Air-Brakes.

Specifications for Air-Brake Hose. G. P. Campbell. Discusses some of the causes of failure in air hose, showing that they are not due to poor material. 1500 w. R R Gaz—Aug. 26, 1898. No. 22249.

Car Ferry.

The Car Ferry Boat "Pere Marquette." Illustrated description of a boat built expressly for this route between Ludington, Mich., and Manitowoc, Wis. 500 w. Ry & Engng Rev—July 30, 1898. No. 21875.

Car Gates.

Gates on Cars. George De Haven. Extracts from an address before a meeting of travelling men at Grand Rapids, Mich., with editorial. Explains the operation and states the advantages. 4300 w. Ry & Engng Rev—Aug. 13, 1898. No. 22086.

Flat Car.

Lehigh Valley Flat Car; 110,000-Pounds Capacity. Illustrated description of a car built in 1887 from the designs of John S. Lentz. 700 w. R R Car Jour—Aug., 1898. No. 21975.

Locomotives.

A New Locomotive Cylinder. A description of the cylinder arrangement invented by W. F. and E. W. Cleveland, now on trial on the Intercolonial Railway of Canada. Also editorial. 900 w. RR Gaz—Aug. 5, 1898. No. 21924.

Best Form of Fastenings for Locomotive Cylinders. From a report presented at the 1898 convention of the Am. Ry. Master Mechs. Assn. Ill. 2500 w. Ry & Engng Rev—July 30, 1898. No. 21876.

Class G-6 Consolidation Locomotive for the Chesapeake & Ohio. Engravings, description and dimensions. 900 w. RR Gaz—Aug. 5, 1898. No. 21923.

Darjeeling-Himalayan Railway Locomotives. Illustrated description of engines employed in climbing steep grades, and taking sharp curves. 800 w. Ind Engng—July 16, 1898. No. 22138 D.

Heavy Passenger Locomotive, Baltimore & Ohio Railway. Drawings of the ten-wheel locomotives in use, with data regarding the work they are doing. 600 w. Ry & Engng Rev—Aug. 13, 1898. No. 22087.

Tank Capacity of Large Freight Locomotives. Editorial on the water requirements of heavy freight locomotives. 900 w. R R Gaz—Aug. 12, 1898. No. 22038.

Tests of a Baldwin Locomotive on the Louisville and Nashville. An account of interesting service tests made by members of the graduating class of Rose Polytechnic Inst., under the direction of F. C. Wagner. 2000 w. R R Gaz—Aug. 12, 1898. No. 22036.

The Future Development of the Locomotive. Maurice Demoulin. From the Bulletin of the International Railway Congress. Discusses to what extent engines can be made more powerful and less heavy, the present tendencies and the types likely to be developed. 2600 w. R R Gaz—Aug. 12, 1898 No. 22034.

Mountain Roads.

Note on the Swiss Funicular Railways. (Note sur les Chemins der Fer Funiculaires Suisses.) General description, with very complete table of the Swiss cable roads for ascending steep mountain inclines. 1800 w. La Revue Technique—July 25, 1898. No. 22330 D.

Private Car.

Private Car; Florida East Coast Railway. Illustrated description of the luxurious car built for H. M. Flagler, president of the road named. 500 w. R R Car Jour—Aug., 1898. No. 21977.

Pullman Exhibit.

The Pullman Exhibit at the Omaha Exposition. Duane Doty. Brief descriptions of the five handsome cars; a smoking car, sleeper, dining car, observation car and parlor car. 1200 w. R R Car Jour—Aug., 1898. No. 21976.

Repairs.

Best Methods of Locating and Repairing Defects en Route. Abstract of report to Assn. of RR Air Brakemen. Gives list of defects usually found and suggests remedies. 2800 w. R R Car Jour—Aug., 1898. No. 21978.

Differential Prices for Repairs. An examination of the underlying principles claiming to show the fallacy of the claims for differential rates under the M. C. B. rules. 1400 w. R R Car Jour—Aug., 1898. No. 21974.

Train Resistances.

Train Resistances on Straight and Curved Tracks. Frank C. Wagner. From a paper presented at the Boston meeting of the Assn. for the Advancement of Science. Explains manner of obtaining data and the results. 800 w. R R Gaz—Aug. 26, 1898. No. 22251.

Trucks.

Standard Trucks. E. D. Bronner. Discussion of the merits of diamond and steel-plate types, before the M.C.B. convention, June, 1898. 1400 w. Eng & R R Jour—Aug., 1898. No. 21877 C.

Works.

The Canadian Pacific Shops—Car Department. Brief description of the workshops, and illustrated description of work now receiving special attention. 2000 w. R R Gaz—Aug. 19, 1898. No. 22126.

The Horwich Shops of the Lancashire & Yorkshire Railway. F. J. M. Illustrated detailed description of English shops of unusual interest. 3200 w. Am Mach—Aug. 25, 1898. Serial. 1st part. No. 22223.

The Midland Railway Locomotive Works.

An illustrated description of these important English works at Derby, and the tools in use, with related matter of interest. 5400 w. Engng—July 22, 1898. No. 21845 A.

NEW PROJECTS.

Alaska.

Railway Construction in Alaska. Particulars relating to this work with views and map. 1500 w. Ry & Eng'ng Rev—Aug. 27, 1898. No. 22280.

Ceylon.

The Railways of Ceylon: The Broad and Narrow-Gauge Problem. An interesting illustrated account of these railways, which are very picturesque, with explanation of the slow progress made in railway building. 3000 w. Engr, Lond—Aug. 19, 1898. No. 22406 A.

Chile.

Automatic Inclines and Railway, Junin, Chile. Josiah Harding. Communicated to the British Inst. of Civ. Engs. Describes a railway constructed to connect the nitrate beds, which are generally about 1000 meters above the sea-level, with the coast. 2400 w. Col Guard—Aug. 19, 1898. No. 22299 A.

China.

Railway Enterprises in China. Translations of articles from Chinese papers in regard to the construction of railroads. 1500 w. Cons Repts—Aug., 1898. No. 22081 D.

Congo.

The Congo Railway. An interesting illustrated account of the construction and the difficulties encountered. Also describes the equipment, service, and related matters. 2500 w. Engr, Lond—July 29, 1898. No. 21969 A.

Jungfrau.

The Jungfrau Railway. Edgar R. Dawson. Describes and illustrates the railway being constructed to the top of this mountain whose altitude is 13,720 feet. 2500 w. Scribner's Mag—Sept., 1898. No. 22177 C.

Mexico.

Railroad Construction in Mexico. L. P. Atwood. An account of work given in charge of the writer. 2000 w. Ill Soc of Engs & Surv—1898. No. 22213 D.

South Africa.

Railroad Building in South Africa. Sketch showing existing railroads, and roads now being built as far north as Kimberly and Bloemfontein, with some particulars regarding the work in progress. 1000 w. R R Gaz—Aug. 19, 1898. No. 22128.

PERMANENT WAY, BUILDING AND FIXTURES.

France.

French Railways and their Work. Charles Rous-Marten. A record of the work done on the Le Chemin de Fer du Nord in their express service, with description of the engines and road. 3800 w. Engr, Lond—July 22, 1898. Serial. 1st part. No. 21835 A.

Improvements.

Readville, Dedham, and West Roxbury Improvements. An illustrated account of the abolition of grade crossings, with changes in highways and station facilities, near Boston. 2500 w. R R Gaz—Aug. 12, 1898. No. 22035.

Narrow Gauge.

Narrow-Gauge Railways, Two Feet and Under. Leslie S. Robertson. Read before the Inst. of Mech. Engs. at Derby, England. Considers the reasons for adoption, advantages and disadvantages, various examples of this class, the equipment, &c. Also discussion. 6000 w. Engng—July 29, 1898. No. 21962 A.

Organization.

A Change in Maintenance of Way Organization. Editorial on the change taking place in the management of the Lehigh Valley Railroad. Does not think the step the correct solution of the problem. 1600 w. Ry & Engng Rev—Aug. 20, 1898. No. 22150.

Railway Bridges.

See Civil Engineering, Bridges.

Railway Widening.

Widening of the Midland Railway at Kentish Town. Illustrations with description of important work on an English railway. 2500 w. Engr, Lond—July 22, 1898. No. 21836 A.

Signals.

The Arrangement of Electric Distance Signals in a Block System. (Ueber die Einreihung Elektrischer Distanzsignale in Blocklinien.) Martin Boda. An illustrated description of the signal system used on the Austrian railways, in which an electrical distant signal is used in addition to the usual semaphore. 2500 w. Zeitschr d Oersterr Ing u Arch Ver—July 8, 1898. No. 22317 B.

The "Bootjack" Signals of the Lake Shore and Michigan Southern Ry. Illustrates and describes a peculiar signal in use on the L. S. & M. S. Ry. 900 w. Eng News—Aug. 4, 1898. No. 21939.

The Distinguishing Signal System of Single-Track Blocking. R. J. Hewett. Part first describes a system invented by the writer, capable of indicating the direction of train movement. 1800 w. Ry & Engng Rev—Aug. 13, 1898. Serial. 1st part. No. 22085.

Spanish Railways.

Spanish Railway Property. Gives a far from favorable account of the present condition. 1300 w. Engng—July 22, 1898. No. 21846 A.

Stations.

A New Station at Nashville. Brief illustrated description of an imposing structure to be erected. 400 w. Ry Age—Aug. 19, 1898. No. 22196.

New C. B. & Q. Passenger Station at Creston, Iowa. Engraving and plans of the building which is to cost about $50,000. 700 w. Ry & Engng Rev—Aug. 20, 1898. No. 22149.

Providence Passenger Station. An illustrated description of the train shed, now nearly completed, which has been the point of dispute between the railroad company and the officers of the city. 600 w. R R Gaz—Aug. 5, 1898. No. 21925.

Steel Ties.

Steel Ties on the Netherlands State Railways; 1881 to 1898. Abstract of report prepared by the resident engineer, Ch. Renson, on the general results of careful observations for 17 years, giving interesting and instructive information. 2400 w. Eng News—Aug. 25, 1898. No. 22228.

Strengthening.

The Necessary Strengthening of the Permanent Way of our Railways. (Die Nothwendige Verstärkung des Oberbaues unserer Eisenbahnen.) Dr. Vietor. A paper showing the increasing traffic upon the German roads and a comparison with the railways of other countries in respect of increase of strength. 4500 w. Stahl und Eisen—August 1, 1898. No. 22356 D.

Switzerland.

The Schaffhausen-Eglisan and Thalweil-Zug Railways. (Mittheilungen über den Bau der Linien Schaffhausen-Eglisan und Thalweil-Zug.) An interesting descriptive account, with maps, profiles and details of viaducts and tunnels; giving an excellent idea of railway construction in Switzerland. Four articles, 5000 w. Schweizerische Bauzeitung—July 9, 16, 30, Aug. 6, 1898. No. 22362 each B.

Track Elevation.

Track Elevation in Chicago. Illustrates and describes interesting features in the progress of the work of eliminating grade crossings at Sixteenth Street. 1000 w. Ry Age—July 29, 1898. No. 21873.

Track Elevation of the Erie R. R. through Jersey City, N. J. Illustrates and describes a proposed plan for elevating tracks, and building a new passenger line in open cut across Jersey City Heights, thus avoiding the passage through Bergen tunnel. 900 w. Eng News—Aug. 18, 1898. No. 22125.

Train Resistances.

See Motive Power and Equipment.

Washout.

Railway Washouts. (Ueber Hochwasser-Katastrophen der Eisenbahnen.) A. Lernet. With especial reference to disasters occurring in Austria in 1896, with illustrations of temporary bridge, and protection to embankments. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—July 22, 1898. No. 22320 B.

Welding.

See Street and Electric Tramways.

TRAFFIC.

Fares.

Railway Passenger Fares and the Cost of Transportation. (Selbstkosten und Tarifsysteme der Eisenbahnen.) H. Klett. A comparison of the zone system with the distance system as operated in Hungary and Germany. 3000 w. Zeitschr d Ver Deutscher Ing—July 23, 1898. No. 22310 D.

Greater London.

Greater London Railways. Report of the returns for the first half of this year of the Metropolitan and the Metropolitan District railways, showing growth of traffic. 1200 w. Engng—Aug. 12, 1898. No. 22157 A.

STREET AND ELECTRIC TRAMWAYS.

Alternating Currents.

The Application of Alternating Currents to Electric Traction. C. H. Davis and H. C. Forbes. A completion of the article in the August issue, especially comparing the advantages of local power stations and distant natural sources. 4000 w. Engineering Magazine—September, 1898. No. 22387 B.

Boston Subway.

The Boston Subway. Brief illustrated description. 1000 w. St Ry Rev—Aug. 15, 1898. No. 22285 C.

Boston Tramways.

The Boston Elevated Railway Company. Reviews the history of street-railroading in Boston, which is considered to have one of the finest systems in the country. Ill. 11500 w. St Ry Rev—Aug. 15, 1898. No. 22284 C.

Copenhagen, Den.

Fares and Earnings of the Copenhagen Tramways. V. Faber-Madsen. An account of the conditions prevailing in Copenhagen, where the average fare paid is 2.67 cents, with information concerning wages paid, cost of operation, &c. 5000 w. St Ry Jour—Aug., 1898. No. 21898 D.

Electric Railways.

The Electric-Railway Systems of Springfield and Holyoke, Mass. Illustrated detailed descriptions of the systems of the two cities named and their equipment. 3300 w. St Ry Jour—Aug., 1898. No. 21897 D.

Paris.

Electric Traction in Paris. L. Bayly. Brief illustrated description of the Madeleine-Courbevoie line, the cars being operated by the accumulator system. 1200 w. Elec Rev, N. Y.—Aug. 17, 1898. No. 22098.

Power.

Power Necessary to Keep Tramway Cars in Motion. Describes the method of computing the horse power. 1200 w. Ry Wld—Aug. 4, 1898. No. 22154 A.

Power Consumption.

Power Consumption in Electric Railroading. S. T. Dodd. Read before the Civil Engs.' Club of Cleveland, O. Part first is mainly devoted to the consideration of frictional resistance. 900 w. Elec Eng, N. Y.—Aug. 18, 1898. No. 22105.

Projects and New Construction.

Cork Electric Tramways. Beverley Griffin.

Read at meeting of the Municipal and County Engs., Cork. Illustrated description of plant. 1600 w. Elec Eng, Lond—Aug. 12, 1898. No. 22178 A.

Middlesborough, Stockton, and Thornby Electric Tramways. A finely-illustrated description of an English inter-urban street railway constructed by the Imperial Tramways Company on Tees-side. 5500 w. Ry Wld—Aug. 4, 1898. No. 22153 A.

The McGurty High-Speed Electric System for Mail and Express Service. Illustrates and describes the system. 800 w. Elec Eng, N.Y.—Aug. 25, 1898. No. 22208.

The Blackpool and Fleetwood Electric Tramways. Brief illustrated description. 1400 w. Elec Rev, Lond—July 22, 1898. No. 21815 A.

The Bradford Electric Tramways. Illustrated detailed description of an English municipal tramway. 1300 w. Elec Rev, Lond—July 29, 1898. No. 22011 A.

The Chicago and Milwaukee Electric Railway. A brief description of this suburban or interurban line, a portion of which was recently opened for traffic. 2300 w. Elec Rev, N. Y.—Aug. 24, 1898. No. 22202.

Speeds.

Tramway Speeds. M. H. Geron. A report presented to the Union Internationale Permanent de Tramways. Data from various countries operating lines either by steam, horses, compressed air, electricity, and a combination of these methods. 3800 w. Ry Wld—Aug. 4, 1898. No. 22155 A.

Tracks.

Recent Track Construction of the Sioux City Traction Company. Chester P. Wilson. Extracts from the specifications showing details of construction, with explanatory notes. Ill. 2500 w. St Ry Jour—Aug., 1898. No. 21899 D.

Underground.

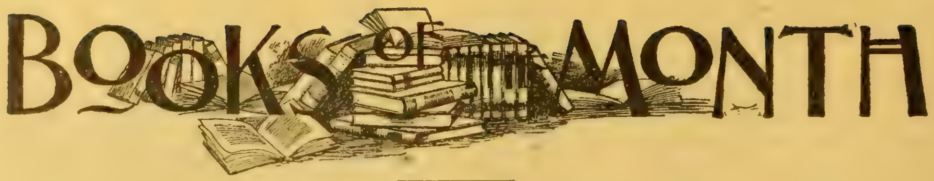
The Underground Railways of London. Frederick E. Cooper. A very fully illustrated account of the underground railways of the metropolis, from the first undertakings to the latest projects. 6000 w. Engineering Magazine—September, 1898. No. 22384 B.

Walker System.

The Walker Conduit Electric Street-Railway System. Describes the most recent improvements in this system which has worked so successfully in New York and Washington. Ill. 900 w. Eng News—Aug. 4, 1898. No. 21,-942.

Welding.

Electric Welding of Street-Railway Rails. Gives an account of the experience with welded joints in 1893, reports experiments, tests since made, and describes the work being done on the Nassau Ry. of Brooklyn. Ill. 1600 w. Eng News—Aug. 4, 1898. No. 21946.



BOOKS OF THE MONTH

The Storage Battery, A Practical Treatise on the Construction, Theory and Use of Secondary Batteries. By Augustus Treadwell, Jr., E. E. London: Macmillan & Co , Limited. New York: The Macmillan Company. 1898.

It is hard to see how a more comprehensive or intelligible book could have been written on so highly specialized a subject. From an examination of its pages we are convinced that it will be of use, not only to the man who is engaged in the constant employment of storage batteries, but to those others who, not so well acquainted with the art, may find it necessary to investigate its economies and applications.

Nor will its service end here. Because of the wide field which he must cover, the engineer-at-large is inhibited from knowing the progress in every branch of his profession at the time it takes place, but by such careful condensations as are represented by this book, he who reads may with great facility, follow and understand what is being done in cognate subjects.

The author begins with a general account of the different cells and their contents. Next he describes the processes of manufacture of the "lead-sulphuric-acid" genus which is succeeded by a chapter on the prevention of buckling and the preparation of active material. This is followed by a relation of the methods involved in the preparation of the "lead-copper," the "lead-zinc," the "alkaline-zincate" and other miscellaneous types of cells. About thirty pages are then given to an extremely clear discussion of the theory.

Chapter VII is entitled Applications, and contains short but ample account of many installations in various cities of Europe and America.

A special chapter is devoted to the applications of accumulators to electric traction in which the author confirms the general impression that no tangible success has attended their use in that field in the United States, although (to quote his words): "In Europe . . . accumulator traction has a decidedly better outlook."

This is followed by a thorough review of the whole subject which includes some suggestions as to the probable course of future improvements.

The book is quite fully illustrated with drawings of the different cells and their parts, resistance and discharge curve-diagrams, plans of installations and half-tone reproductions.

Methods of measuring the internal resistance and the E. M. F. are given in an appendix which concludes with a tabulated list of a large number of batteries, showing what they are intended for, what the containing-cell is composed of, their efficiency, rate of discharge, etc.

A Short Course in Inorganic Qualitative Analysis: For Engineering Students. By J. S. C. Wells, Ph. D. Instructor in Analytical Chemistry, Columbia University. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. 1898.

Dr. Wells has succeeded in his avowed object, which is, without departing from the familiar plan of Fresenius, to make his treatise as concise as possible. He makes a most commendable effort also to avoid mere mechanical work on the part of the student by impressing the purpose of every use of a reagent, and this end is well aided by the tables of reactions, which accompany, in parallel, each scheme for group separations. It would seem as if, in the introductory chapters, the explanation of the writing of reactions might precede, more logically than follow, their use in discussing chemical changes, and that the definition of bases and acids should be introduced prior to the frequent use of the terms in defining the groups. But these matters should all be familiar to the student before he enters the laboratory; in introducing them into the manual, Dr. Wells doubtless only seeks to remedy a too frequent deficiency in the students coming under his charge.

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THE CHINESE, AND RECENT INDUSTRIAL PROGRESS IN CHINA.

By J. S. Fearon and E. P. Allen.

IMAGINE an empire greater in area than the United States or Canada, occupied by a population of 500,000,000,—a population possessing a highly developed civilization, industrious and peace-loving, whose appreciation of the importance of trade is not second to that of the great commercial nations of the west,—and you may have some conception of the magnitude of the new field for engineering enterprise which is now being opened to the world. China is not a new country; it requires no pioneer. No railroad constructed through its territory will have to import its patrons; no mine opened in its hills and valleys will have to send its product to far markets. The producer and the consumer are alike on the ground. The opportunities are ready made; all that is wanted is the application of western science to the means of production and transportation in order to make of China a country of the greatest developed wealth.

It is strange that, with so long a peaceful occupation of their land, with natural resources so rich and varied staring them in the eyes, and withal themselves gifted with a high degree of intelligence and a never ending activity of mind and hand, the Chinese, left to themselves, have yet been able to progress only so far and no farther; but there seems to be a possible explanation. Dr. W. A. P. Martin, an American, who has lived some forty years in Peking, for twenty years has been the president of the Imperial Tungwan College, and has lately been called to the presidency of the new Imperial University established in that city, and who has therefore had ample opportunity to observe the mental characteristics of the Chinese, remarks that

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they seem to lack the ability to apply abstract principles to practical affairs. In other words, the Chinese lack the synthetic faculty, and have but vague and impractical ideas of natural law. The inventions attributed to the Chinese are of the obvious sort, literally "invented" or "come upon." Having observed the polarization of a needle, accidentally placed in favorable conditions for that phenomenon, the application to use in the mariner's compass is obvious, and the Chinese had the mariner's compass in very early days; but they did not induce the laws of magnetism from the small beginning of the polarized needle, as we have done, and have in consequence stopped short with the obvious compass, while we have, from the laws once ascertained, not invented, but deduced and contrived, a multitude of the most wonderful appliances which now form a matter-of-course part of our daily life.

Yet this does not mean that the Chinese are incapable of progress; for, however much they may be lacking in the synthetic faculty, they are well-endowed with the analytic; they are capable, in a word, of understanding anything that is capable of demonstration, and, having once seen and studied, they are able to imitate to the smallest particular. It follows, therefore, that, in order to bring China forward to a prominent position in the industrial and commercial world, it is necessary only for the west to show the way.

China's conservatism is a by-word among the nations, but it is not a quality to be despised; for it has been the quality that has held together the vast empire for these thousands of years. Without it we should now have, not one people to deal with, but a score or more. The semi-autonomy of the provincial governments is bad enough as it is; but how much worse it would be if even the shadow of imperial authority no longer covered the whole land! It is to the interest of western nations that the central authority in China shall be upheld, and particularly is this to the interest of the United States. The destruction of the central government at Peking would mean a breaking up of the empire along the lines of provincial cleavage, and that would entail a serious retardation of all progressive measures of imperial dimensions now projected. Fancy the difficulty of constructing, and the greater difficulty of operating, a railway from Peking to Canton, across half-a-dozen frontiers, with innumerable taxes to pay and endless official interference to oppose! Such a condition would not be permitted to remain, and the destruction of the Peking government would therefore be the signal for a final and irrevocable partition of China, in which the United States would scarcely have a part. If China is divided, England would come into her share without aid from the United States, and there would be no share for

Americans to appropriate. It will be too late for the United States to seek a benefit by arraying themselves on the side of England when her operations and influence are confined to the valley of the Yang-tze. Russia, Germany, and France seem already to have acquiesced in England's supremacy in central China, and, if England must give up the fight for the open door throughout the empire, she can have the Yang-tze valley as a *quid pro quo*, and will not need any assistance, moral or other, from America. But England is far from showing any disposition to confine herself to the Yang-tze valley. In the southwest the boundaries of the important Chinese province of Yünnan are coterminous with those of England's possessions in Burmah, and England purposes to extend her influence northward from Burma *pari passu* with the extension of French influence northward from Tong King. In the province of Shansi at the north an Anglo-Italian syndicate, known as the Peking syndicate, has acquired concessions for exploitation covering an area larger than that of Great Britain. The great rivalry is therefore not appeased; the question of the open door is not settled, and the opportunity is not yet gone from the United States.

They have certain treaty rights in China. If they do not extend these rights, they should, at least, maintain them. It is their right to trade on the same terms as other treaty nations at every open port. But their treaty rights with China do not extend to any territory the sovereignty over which China has ceded to another power. When therefore the United States stand idly by, and merely watch the slow encroachment of Russia, Germany, and France upon the sovereign rights of China, they are permitting themselves to be robbed without protest. The controversy over Newchwang is a case in point. The Chinese government had arranged to borrow from the Hongkong and Shanghai Bank, a British institution, the money needed to complete the Imperial railway from Peking to Newchwang, in Manchuria, and to mortgage the Newchwang extension to the bank as security. Contracts to this end were duly signed. Russia, fearing the possible ultimate British control of the railroad in what it claims as its own peculiar "sphere of influence," which would result from a default in payment of principal or interest of the loan, brought to bear so strenuous pressure that the government was induced to break its contract. Russia, however, had no interest in the completion of the Newchwang road, even under other control; she had the further object in interfering with the loan in question, that her plan is to make her Manchurian coast connection, not with Newchwang, which is an open treaty-port, but, disregarding that point altogether, to pass it fifteen miles to the eastward, and make an outlet at Talienwan, which she holds by lease from the Chinese government, and which it will be her purpose to build up to the detriment of Newchwang. It was only after diplomatic interference of the British government that the rights of the Hongkong and Shanghai bank received recognition. Americans are as much interested in this controversy as the English, if not more so, because a very large part of the foreign trade in Manchuria is American.

Heretofore American merchants abroad have been very much left to shift for themselves, and not infrequently they have found it difficult to obtain from Washington the influence and backing necessary to maintain their rights. If the American nation desires now to inaugurate a policy of imperialism really effective and beneficial, it cannot do better than eliminate, as far as possible, all territorial bounds, and bring its government to guarantee to every citizen, whereever he may be, its full protection against wrong and its full power to enforce right. The government need not take the initiative, if the citizen is sure that its influence will follow him wherever he may go. And the influence of the government must follow the American into China, if American enterprise in that country is to be encouraged, for the conditions are such that governmental pressure may frequently be necessary to compel the Chinese—and particularly the Chinese official—to live up to his contract. The Newchwang railway loan may again be referred to as a case in point. There is therefore the strongest possible reason for the Anglo-Saxon nations to co-operate in policy as to the future of China.

The Chinese have an elaborate system of jurisprudence; their abstract conceptions of right and wrong are seldom at fault, even when viewed from our standpoint; but their practical morality and their administration of law fall far short of the condition which would promote easy and safe commercial intercourse. In strict accordance with the utilitarian principles governing the evolution of morals, the Chinese merchant has achieved integrity simply because he has learned that honesty is the best policy, and that without honesty in himself he cannot expect honesty in his fellow; but the average official knows no policy except that of lining his pockets while he has the opportunity. Happily, there are notable exceptions; but the honest statesman in China is seriously, and sometimes overwhelmingly, handicapped by the numerical preponderance of the class of self-interest. The verbal agreement of the Chinese official is generally worth nothing; his written contract is of scarcely more value, unless obligation is allied with self-interest. Americans now contemplating engineering enterprise in China should arm themselves, in every possible way, against breach of contract, and there is perhaps no means to this end so efficient as the enlistment of Chinese co-operation, and financial co-responsibility.

These observations, of course, do not apply to enterprises within the limits of the extra-territorial jurisdiction of treaty ports. At these ports, and notably at Shanghai, the great commercial center of the east, there are opportunities to operate under peculiarly-favorable auspices, and with the minimum of interference by Chinese officialdom.

It is to the credit of the Chinese that, even when they recognize the benefits to be derived from the introduction of the material improvements of the west, they are still unwilling to throw open their country indiscriminately to the foreigner, but prefer themselves to take as large a part as possible in the new development.

The Chinaman has some force of character, and resents most strongly the encroachment of the "barbarian," as he terms all outlanders,—resents it not merely as the savage African does, but with patriotic feeling and a natural desire to owe his progress to no one but himself. Years ago China was warned by a far-seeing and sympathetic missionary, Dr. Allen, of Shanghai, in his book, "China and Her Neighbors," that, if she did not develop her own resources, the foreigner would do it for her, and bring her to the condition of another India or Egypt. Some of her statesmen have heeded the warning, but they have found it difficult to move the great inert mass of the people. Comparison is frequently made between Japanese advance and Chinese stand-still; but, without regard to stability of character, it is easier to move forty millions than five hundred millions. Yet the leaven has been working strongly of late, and results are showing. Despite palace revolutions, there can be no withdrawal now from the march of progress. The whole civilized world is behind China to push forward the unwieldy mass which her own nerves are inadequate to direct. Nothing has proved a stronger lever to uplift the Chinaman from his medieval drift than the hurt to his pride which has come from the contempt and distrust of his institutions expressed in the extra-territorial provisions of the treaties with western nations; a recent demand of Japan to be placed in the same category with western nations in the matter of extra-territorial jurisdiction has been the unkindest cut of all. It has taken a long time to convince even the few among the people that this distrust at least was justified; but now a Chinaman is to be found who says, with Confucius: "The first thing for a man to learn is his faults; then the good he learns in the morning he can make his own and practice in the evening." In other words, recognition of defect must precede the search for, and application of, the remedy. China has become convinced that there is a world, and a great one, beyond her borders—that the "outer nations are no longer insignificant," and that it is worth while for her to prepare herself to take her place in the greater family of nations, assuming no superiority, but grateful for recognition as an equal. The leaders of thought and action among her people are, therefore, anxious to promote progress in every direction; but, unfortunately, they do not realize that the chief claim to national equality is not in equal material advance, but in equal moral advance. It is proposed to revise the body of Chinese law; that work is even now quietly on the way, and the establishment of laws less alien to western ideas will do much to break down existing barriers; but, until the practical morality of the people has advanced beyond the possibility of tolerating the corrupt administration of law and government that now obtains, no change in the letter will accomplish any real progress.

So much for the social conditions which will confront the foreigner in China. But, when the difficulties presented by these conditions are successfully evaded or guarded against, the field of enterprise that opens before the engineer is unparalleled in its richness and variety.

The coalfields of Shansi alone, according to von Richthofen, will suffice, at the present rate of consumption, to supply the world for a thousand years. The province of Kansu is not far behind; no department of this province appears to be without considerable deposits, and, in some departments, the supply is enormous. "The coal formation extends, with few interruptions, from eastern Shansi to Ili, through 30 degrees of longitude, and it is also found near Ili and Yarkand." Much of the coal is anthracite, and the bituminous variety is of high grade. Von Richthofen says the province of Shansi will take the palm from Pennsylvania in its coal area, and by a relatively greater proportion. Says Mr. Colquhoun, in his "China in Transformation:" "Nor is its extent the only advantage possessed by the Chinese coal-field, the ease and cheapness with which coal can be extracted being a remarkable feature. This region, however, labors under the disadvantage of being situated at a distance from the coast and from navigable rivers; and the coal formation lies a few thousand feet above the adjoining plain, a difficulty which will be overcome by the railroads required for the exploitation of the mineral wealth of Shansi."

"The district of Luiyang, from which the famous coal of this name comes, forms the most important mining center of a region which is broadly estimated as extending over 20,000 square miles. It is from this source that the future coal-supply of central China must chiefly be drawn, but it is the extent of this vast field, in addition to the commercial capacities of so populous a region, which renders the opening of Hunan to foreign enterprise a matter of such importance. The coal has long been worked in many localities, under the primitive methods of Chinese surface-mining, for purposes of local supply, and a varying quantity (probably some 200,000 tons a year) is sent to Hankow, four hundred and thirty miles distant. The Luiyang and Yungling mines are capable of producing an unlimited supply, the cost of which would be nominal with good communications and scientific methods of production.

"In Hunan the fields bordering on the line of the proposed Luhan railway—*i. e.*, the Peking-Hankow line—produce an excellent quality of bituminous coal, sold at about 3s. at the mines, and iron ore occurs profusely throughout the coal-bearing strata of this district, while in north Hunan there is also an anthracite belt. Coal from these mines finds its way to the Yellow river and the Wei, about thirty miles distant, where it commands a price five times that paid at the pit-mouth.

"In Shansi, still bordering on the Luhan railway line, lies the great coal and iron region of Tszchow Fu, favorably situated at a distributing center. In northern Shensi, also rich in coal, the difficulties of transportation place it entirely beyond the reach of any but the adjacent places. The coal formation in the bottom of the ravines is so similar to that of Shansi as, in Richthofen's opinion, to make it probable that the table-lands of coal extend over the greater portion of northern Shensi."

The coal deposits of the upper Yang-tze valley are described by an engineer in the *Imperial and Asiatic Quarterly Review* for July, 1898, as follows:

"Ten miles below the city of Suchau, (situated at the confluence of the Min-Kiang and the Yang-tze, 1,750 statute miles from Wusung) we arrived at the great coal-mines of Pa-Ko-Shau; and on examination it was proved that this coal was superior to that found in any other part of the river we had yet explored, and, under the action of heat, it was far more combustible. Extensive mining was being carried on by horizontal galleries. Iron is also found in this neighborhood. After ascending 25 miles above Su-chau, we came to the great Coal-Gorge (so named by us). This is 14 miles long, the cliffs on either side being from 500 to 600 feet in height. The coal-seams crop out from these precipices, and at every turn the galleries were being worked by the natives, some of these galleries being 400 feet above the level of the river. The coal is sent down in baskets, on two permanent taut ropes, to the junks below, the empties being carried up by the weight of the descending load. At some places the height at which the coal is worked is so great that two or more of these contrivances are necessary, one bringing down the coal to a half-way landing, and the other thence to the river. A vast number of junks transport the coal to Su-chau, thence ascending the river Min to Ching-tu, the capital of Sze-chuan."

Coal of excellent quality is also found in Yünnan, which is south of Sze-chuan.

The only coal mines in China that are now being worked to any considerable extent and with foreign machinery are the Kaiping mines in northern Chihli. These mines have a yearly increasing output, and are a decided success. The present output is 1,500 tons per day, and a new shaft is now being sunk which will double that amount. Their product is taken partly for the imperial navy, but is chiefly consumed by Shanghai, where exists a demand largely exceeding the supply. The mining company owns and operates four large steam colliers in its Shanghai trade.

Salt is found in great quantities, notably in the extreme west, and the salt gabel is a very important part of China's internal revenue, amounting to some 13,952,000 taels (ounces of silver) per annum. Iron, copper, gold, silver, lead, tin, and zinc are found in many parts of China and in great abundance. The mineral wealth of the southwest provinces, Yünnan and Kweichow, however, is especially remarkable. There sulphur, mineral oil, and mercury are also found. The chief obstacle to mining in that section is the periodical flooding, which native appliances are insufficient to prevent or remedy.

Copper and lead are produced chiefly in Hupeh and Hunan, and in the southwest provinces before mentioned. Copper is also believed to exist in Shantung, the present German "*hinterland.*" Despite the large deposits of copper ore which have been noted in China, a great deal of copper has been, and still is, imported from Japan. It is largely used in the common coin of the realm, popularly known as cash. Chinese copper cash may be said to be on a bullion basis, and, with the decline of silver, they have risen in value from 1,100 to the silver dollar to 800 to the silver dollar; notwithstanding their value as currency, the scarcity of copper for use in the arts is such that, of late years, cash have been melted down in appreciable quantity.

Gold is found in many provinces of China proper and in Manchuria. Silver is also found in various parts of the empire, and has long been mined, but in a measure that has not prevented China from being a principal consumer of the American product. The exploitation of placer gold deposits in the valley of the Moho, near the Amur river, was projected and commenced in 1888. Li Hung-Chang advanced 100,000 taels, and the military governor of Hei

Lung Chang 40,000 taels, toward the preliminary expense. The scheme was first to repay the loans and then to divide net profits in the proportion of 30 per cent. to the support of the army, 20 per cent. as a bonus to the men employed, and 50 per cent. to the shareholders. Gold was then being mined under American engineering superintendence near Pingtu in Shantung. Near Jeho, also in Shangtung, two mines of argentiferous lead ore were being worked with foreign machinery as early as 1888. At each mine a shaft 300 feet deep was opened to water-level. The natives had mined in that locality for forty years, and had taken out all the ore down to the water-level, but their appliances were unequal to the task of going further. It remained for the American miner to import pumping and hoisting machinery from San Francisco, and take up the work where the native had left off. The funds for the machinery, some 30,000 taels, were furnished by the viceroy of the province. He was especially interested in the lead product of the mines, because no lead mines, as such, had theretofore been worked in China, and that metal was largely used for military purposes.

The telegraph is the only institution of modern science which has obtained any considerable foothold in China. Peking is connected by wires with Tientsin and with Manchurian points up to the Russian frontier, whence connection is continued by Russian Siberian lines to Europe. The capital is also connected with all the treaty ports and principal cities in China proper, and these again with each other. Canton has connection also through Yünnan with Burma. China learned the value of the telegraph in the war with France, and it has long since been admitted to have "become indispensable." The telegraph, however, is under imperial control, and there is probably little opportunity for its extension as a private enterprise.

Chinese writing being not alphabetic but syllabic, and there being as many characters as there are words in use, the telegraphic messages are sent in a number cypher. For transcribing messages received a double-ended type is used; on one end is the character, and on the other the corresponding number. When a message is received, it is set up by the numbers, and then printed from the reverse, or character, end.

Government arsenals and shipyards have not been established in China to any considerable extent, but the arsenal on the Woosung river, near Shanghai, is worthy of more than passing notice. It has been in operation under British superintendence for some thirty years, and at the present time is doing much and very creditable work, turning out, for instance, guns, from small arms to 12-inch cannon. The plant includes two Siemens-Martin steel furnaces and a 2,000-ton forging press. All the steel for guns up to 6″ calibre is made from native pig, and cast and forged at the works. More than two thousand men, all Chinese, are employed, and under their British superintendents they have developed a very satisfactory skill.

A staple agriculture product of central China is cotton, and it is in Shanghai that the industry of cotton manufacturing has established itself and is fast reaching most considerable proportions. There are now, at Shanghai, nine cotton mills with a total of 375,000 spindles. The product is almost wholly yarns, which are woven by the peasantry on hand-looms in their otherwise-idle winter months.

The cotton of China is of exceedingly short staple, and the improved saw gin of American short-staple practice has been found unsuitable. The less-satisfactory roller gin is now employed in Shanghai; the question of an improved gin, adapted to Chinese cotton, presents an excellent opportunity for American invention.

The subject of railroad development in China, in which the engineering world is now taking a very active interest, will be treated in the next number of THE ENGINEERING MAGAZINE.

THE STEEL FOUNDATION OF THE SHIP-BUILDING INDUSTRY.

By James Riley.

THE latter half of the century now nearing its close has witnessed the commencement and rapid development of the manufacture and use of steel, and therefore deserves to be called, as it is, the age of steel. In this development there has naturally, and indeed inevitably, been large opportunity for the exhibition of the interplay between improved material and increased application. New uses have imposed steadily-increasing requirements; the satisfactory fulfillment of these requirements has resulted in increased utilisation and enlarged production, which has again enabled higher economy in manufacture and stimulated still fuller employment. This is especially observable in the applications of steel to structural work, and preëminently in the vastness—the completeness—of its adoption in naval construction and marine engineering.

At the end of the "fifties" Bessemer was deeply and anxiously engaged in perfecting his magnificent invention, the "pneumatic" or "bessemer" process for the manufacture of steel "without the use of fuel."

The end of the "sixties" saw Siemens similarly engaged with his beautiful "open-hearth" process, which, by reason of the readiness and comparative ease with which the products could be controlled, was to win eventually preëminence over its great rival in the matter of regularity and uniformity of product.

By his singularly opportune production of "the triple compound" of carbon, manganese, and iron—"spiegeleisen"—Mushet had saved both the great processes, if not from absolute failure, at least from extremely serious difficulties, and had rendered possible the production of metal capable of innumerable applications.

The utility of spiegeleisen depended on its carbon and mangaese, and their relative proportions. The carbon was a fairly constant quantity, about 5 per cent.,—and the manganese ran about 10 per cent., rarely exceeding 12. In using this tolerably definite compound it is evident that, in adding to the refined pig iron in the "convertor," or furnace, a sufficient quantity to furnish the resulting steel with the desired and necessary percentage of manganese, there was also added a more or less definite quantity of carbon. The characteristics of steel in the matter of strength, ductility, etc., are largely dependent on the carbon it contains, but the quantity of carbon which could be added from the spiegeleisen was controlled by the proportion of manganese the latter contained and the quantity which it was permissible or desirable to add to the steel. The other possible method of varying the content of carbon in the steel was to leave more or less carbon in the bessemer "blow" or the Siemens "charge;" this residuum added to the carbon furnished by the spiegeleisen would give the desired percentage in the steel. It is evident, however, that, even if the "blow" for "charge" were thoroughly decarburized, it was not possible to reduce the carbon in the steel below a certain minimum dependent on the composition of the spiegeleisen.

Hence, there was a definite restriction on the steel product in the direction of "softness," "mildness," ductility, etc., qualities which were so much desired for many purposes.

Extended range of variation in this direction could not be accomplished until the "triple compound" could be made with larger proportionate contents of manganese, and this did not appear possible while its production was confined to the ores then in use.

In 1872, however, there was a "spiegeleisen famine," due to the Franco-German war; the writer of this article was urged by his employers to try to give them relief, and as there were no ores of the usual character available, determined to try the manganiferous ores of the south of Spain.

In the end perfect success was attained, a new source of supply was made available, and—what was also important—it was found possible to nearly double the manganese. Thus the utility of the "triple compound" was largely increased, and the steel-maker enjoyed a larger range in the variation of his product.

Important though these new processes and products were, however, still more important operations were in the meantime being conducted elsewhere, and with results which were to effect a complete revolution in the iron trade, and to have undreamed-of effects in many other directions.

Henderson, of Glasgow, had discovered a process by which he could produce a compound, subsequently known as ferro-manganese, which held more than double the quantity of manganese contained in the richest known spiegeleisen, although accompanied by a larger proportion of carbon. No one was found in Great Britain to appreciate and make use of this valuable invention, and in the end the patents were acquired by the Terre Noire Company of France.

In 1874 some of the directors of the Landore Company, Swansea, had information that the Terre Noire Company was producing specially fine, soft, ductile steel, adapted to many uses for which ordinary mild steel is not suitable. After correspondence and fuller information it was decided that one of the directors (Mr. Chas. Liddell), the chemist (Mr. Arthur Willis), and the general manager (the writer of this article) should visit the Terre Noire works and investigate the new process. Circumstances prevented the writer from paying the intended visit. The report furnished by the visitors showed that the special metal was produced in the open-hearth (Siemens) furnace, and that its special qualities were largely due to the use of (what was termed) ferro-manganese, instead of spiegeleisen. It was determined to experiment at Landore with the new alloy, or compound, and half a ton of it was bought, at a cost of about forty pounds. It proved to contain about fifty per cent. of manganese. (To-day such ferro-manganese would not cost more than a tenth of the price of that first parcel.) Here, then, were the means of adding to the steel the necessary percentage of manganese with a restricted quantity of carbon, and thus the range of variation was still further extended in the direction of softness and ductility.

Thus far attention has been confined to manufacturing processes; now other influences must be considered.

The incessant rivalry between England and other countries necessitates ceaseless efforts to possess the finest, strongest, and most powerful ships, guns, etc., and fixes on the high officials of the British admiralty and war office serious responsibilities. It is essential that they be acquainted with the advances made in the various branches of metallurgical science, in so far as these affect the materials used in the construction of ships, etc.

This knowledge, to be complete, must extend to results obtained in foreign countries as well as at home. An apt illustration of the vigilant attitude maintained in these matters, and of the great service that may thus be rendered, is furnished by the following incidents.

In 1874 Sir Nathaniel Barnaby was chief naval architect of the royal navy. In that year he visited some of the dockyards of France, and "had an opportunity of seeing the iron and steel materials used in building the ships of war for the French navy." In March, 1875, he startled the home manufacturers by declaring, with regard to the steel they made, that naval architects had a "distrust of it so great that the material may be said to be altogether unused by private shipbuilders, except for boats and very small vessels, and masts and yards; and marine engineers appear to be equally afraid of it." He further implied that it was not equal to that supplied to the French yards.

But even with this latter material he was not satisfied, for, after detailing the regulations for its necessarily careful treatment, he said "that a material which needed such care in its treatment would stand but a very poor chance in an ordinary shipyard. I, for one, should feel very doubtful about a ship built of it for myself, unless I could see every plate worked." He concluded in words that have been often quoted, which, although they caused serious perturbation in some directions, yet furnished inspiration and encouragement to a better state of things: "The uncertainties and treacheries of bessemer steel in the form of ship and boiler plates are such that it required all the care which it has bestowed upon it at L'Orient to avoid failure. The question we have to put to the steel-makers is: what are our prospects of obtaining a material which we can use without such delicate manipulation and so much fear and trembling? We have gone on for years using iron plates which are a compound of impure irons of different and unknown qualities welded together imperfectly at the rolls. We want a perfectly coherent and definitely carburized bloom or ingot, of which the rolls have only to alter the form in order to make plates with qualities as regular and precise as those of copper and gun metal, and we look to the manufacturers for it. I am ready, for my part, to go further than the French architects have gone, and build the entire vessel—bottom plates and all—of steel; but I know that at present the undertaking will involve an immense amount of anxiety and care. We ought not to be behind any other country in this matter, and it shall not be my fault if we are."

In the spring of the succeeding year the writer was in a position to state that he had, on behalf of the Landore Company, waited on Mr. Barnaby, and offered to accept his challenge; that some time later that company had contracted with the admiralty to supply the steel to be used in the construction of the Iris and Mercury—two armed dispatch vessels to be built at Pembroke dockyard. He also exhibited samples of the material supplied, and described the severe treatment they had received, purposely much in excess of the admiralty requirements.

The test conditions which were at that time specified by the admiralty for ship material were the same as those still in force. They call for a tensile strength of not less than twenty-six or more than thirty tons (one piece in fifty to be subjected to this test) with an elongation before rupture of not less than twenty per cent. on eight inches of original length. The well-known *temper-bend* test was also to be applied to *every* piece of material supplied. At that time the writer was in a position to state that five thousand pieces of plate and angle had been submitted to the resident surveyor (Mr. J. H. Biles, now professor of naval architecture in Glasgow University), and that none had been rejected for non-compliance with the tests, exacting though they were as to the quality of the metal.

It will readily be believed that, with the apprehension of anxiety and responsibility manifest in the words of Mr. Barnaby, the greatest care would be taken in inspecting and testing the materials; yet the writer has pleasure in stating that neither at that anxious time or since has he experienced arbitrary, irksome, or unjust treatment; on the contrary, there has always been a disposition to facilitate, in every possible way consistent with prudence, the satisfactory completion of contracts.

Looked at from the standpoint of to-day, when thousands of tons of such steel are made weekly without serious anxiety or trouble, it is scarcely possible to realise the anxieties and difficulties of that day; yet it is fair to state that to all those engaged in the manufacture of steel for that first contract it was no easy matter.

It may be borne in mind that, previous to the events we have been considering, it had scarcely been possible to obtain steel with a tensile strength of less than thirty-three tons; that, when the new admiralty test conditions were stated (a maximum strength of thirty tons), several firms declined to accept them, and one eminent firm ceased from that time to undertake the manufacture of steel plates.

In the writer's earliest experience in the study of this branch of steel manufacture, some months before entering into this contract, many experimental charges were made, which were unsuitable, as they had a tensile strength of thirty-one tons or more. It was therefore no light matter to enter into a contract calling for the supply of the *new material* on so large a scale that it must become one of the principal items of every-day work. However, by dint of careful selection of materials used, by care and skill in conducting manufacturing operations, and with the aid of ferro-manganese still richer in manganese, these difficulties were gradually obviated or overcome. In connection with the use of richer ferro-manganese it may be mentioned that, having appliances and means at disposal, the writer erected at Landore a small blast furnace (the first used for this manufacture, at all events in England), and produced from it at a reduced cost richer ferro-manganese than had hitherto been available. The contract was completed in a manner so highly satisfactory to the admiralty that it may be fairly said that there was a practical ending of the "fear and trembling" condition of mind, and from that day forward "mild steel" became the ordinary material used in the construction of vessels for the royal navy, as, indeed, it is, not only for warships, but for the mercantile marine of the world.

This narrative exhibits an interesting concatenation of circumstances paralleled, perhaps, at other times and in other industries, but scarcely capable of a more striking exposition than was afforded here. The admiralty were desirous of building better ships; the naval architect was in search of better material, appealing to the manufacturer for it and to some extent indicating not only what it should be, but how it should be produced; the steel-maker was seeking for some occupation for his plant different from the ordinary run of work; the solution of the problem was found in the production of a recarburiser rich in manganese, for the first time available; and, as a result, we have witnessed the production and adoption of a new material and the commencement of a striking revolution which, in its progress, was to affect many of our staple industries.

GREAT RAILWAY STATIONS OF ENGLAND.

By Thomas Cargill.

THE spirit of coöperation which is productive of results so excellent, both ethically and economically, in railway management and operation, is strongly manifest in England, and to it, in great part, should be referred a type of station different from those heretofore described in these articles, and distinct enough to merit a name of its own.

It may or may not be a junction station, but it may be properly called a joint station,—that is, a station used by two or more companies. Generally, though not always, each company has arrival and departure platforms for the exclusive service of its own trains, but, at the same time, there are certain parts—station buildings and offices—which are common to them all. An example of a joint station is represented in plan in Fig. 1,—the Temple Mead Station at Bristol, on the Bristol & Exeter line of the Great Western railway. As may be seen by reference to the plan, the station is essentially a *station de bifurcation*, and the central part of the booking office, as well as the refreshment rooms, are situated in the fork formed by the gradual convergence of all the tracks toward the metropolis. This station, for the purpose of description, may be conveniently divided into two parts, one comprising the straight portion assigned to the South Wales and the Midland departure platforms, and the other, which is on a curve, occupied by the up and down platforms of the great Western line, and the arrival and interchange platform of the Midland railway. The "straight" terminates in a dead end; the curve, which has a radius of 1,000 feet, runs through, and is 500 feet in length between platforms. A curve, even of very short radius, at the entrance to a terminal station, is of very little consequence from an engineering point of view, as the speed of both arriving and departing trains is very low. But, when, as frequently happens, such a curve is laid out at the approach to an intermediate station, a serious blunder is committed; for, while the trains which stop can pass it in safety at their reduced speed, and will therefore be in no wise affected, the mails and other fast trains, which do not stop at the station, must be slowed down, to avoid serious danger of derailment.

Fig. 2 shows an elevation of the exterior front of the Bristol Station, which, together with its central clock tower, its airy-like pinnacles, and its spacious covered ways, is by no means a bad example of combination of the useful with the beautiful. It faces the "Ap-

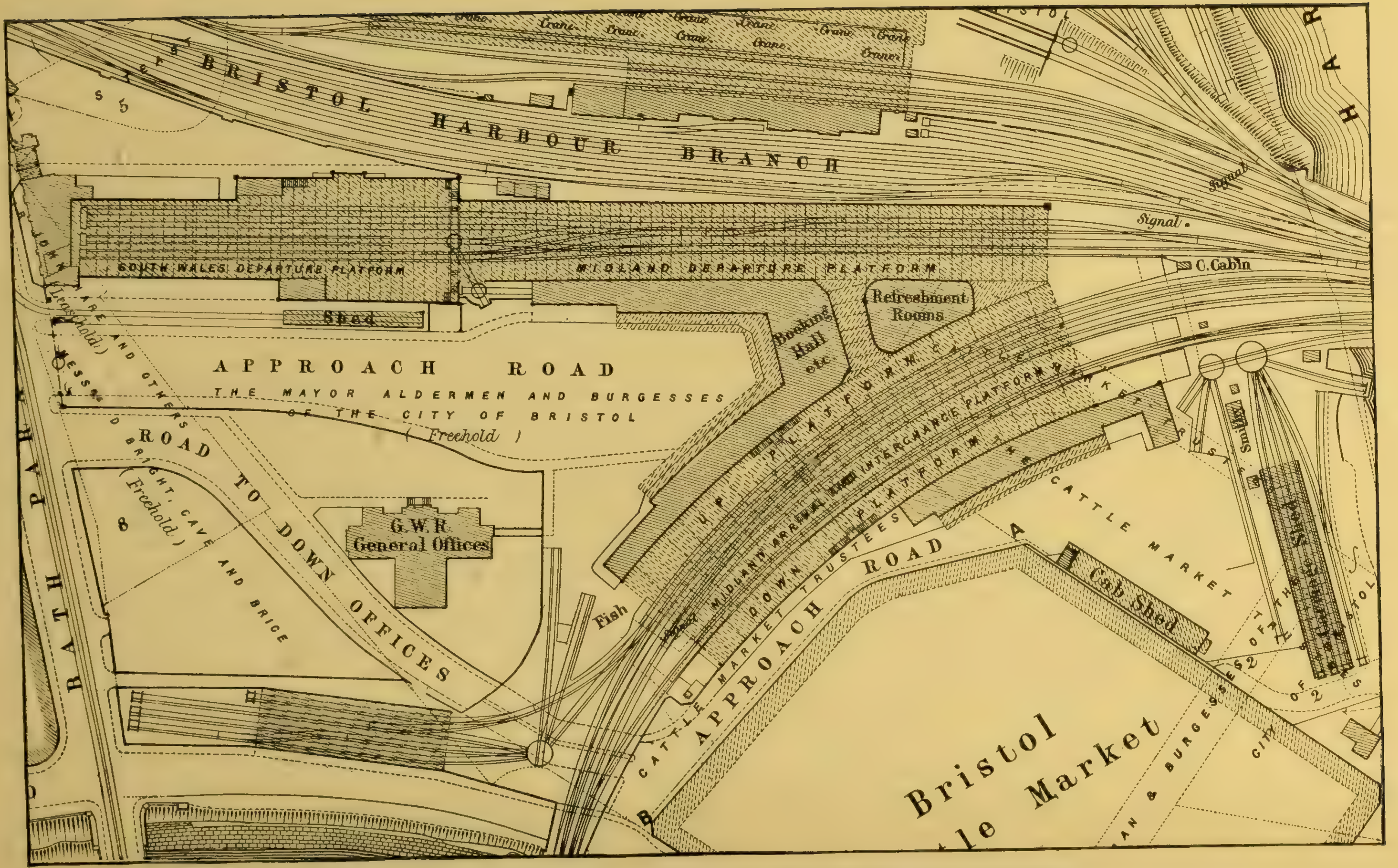


FIG. I. PLAN OF BRISTOL STATION AND ADJACENT TRACKAGE SYSTEM.

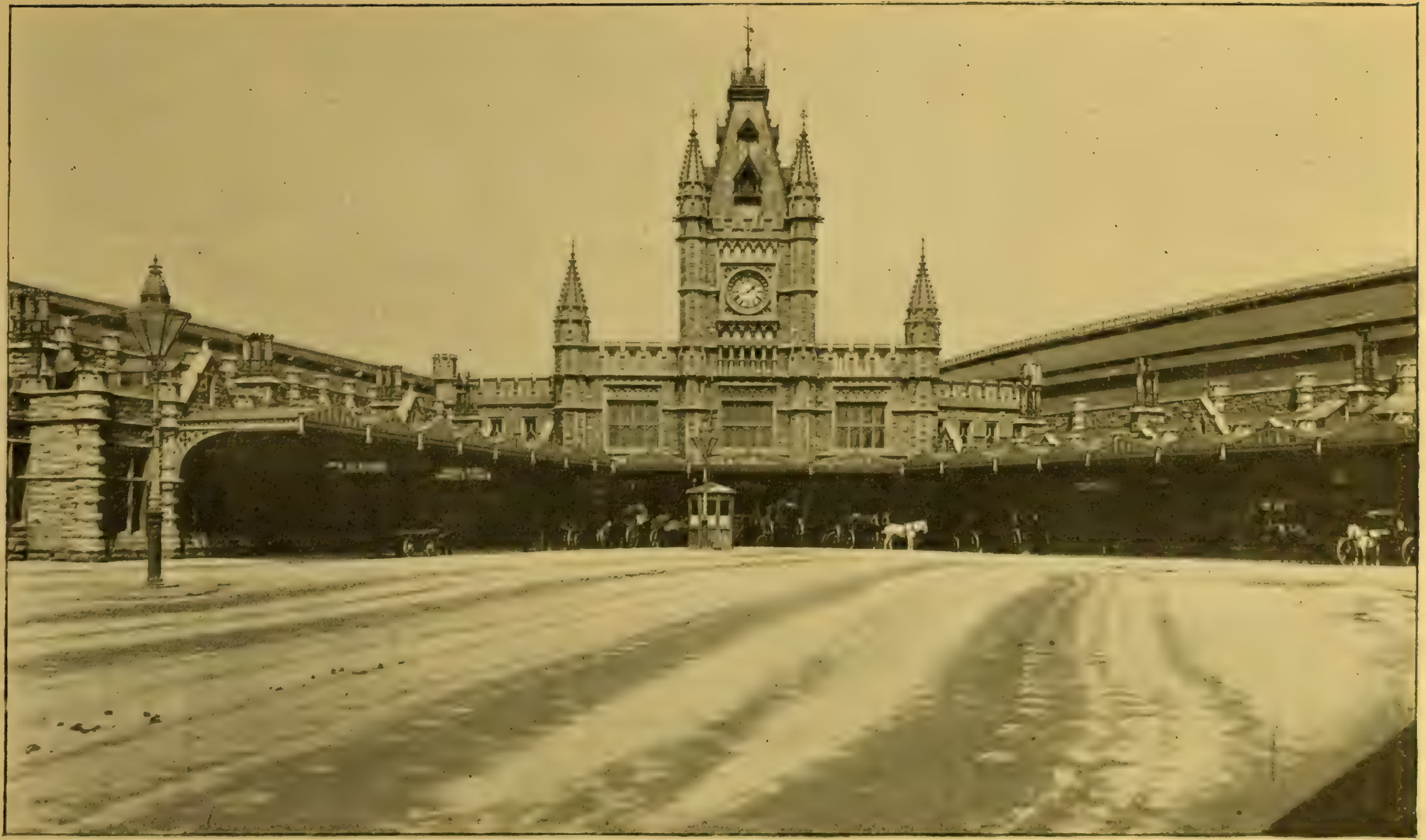


FIG. 2. GREAT WESTERN RAILWAY STATION AT BRISTOL, USED JOINTLY WITH THE MIDLAND RAILWAY.

proach Road," and has two wings, the one on the left communicating on the inside with the Midland departure platform on the straight part of the terminus, and that on the right with the up platform of the Great Western railway. The ridge and one of the sloping sides of the roof covering the curved part of the station are visible also, above the side wall on the right hand side of the photograph, so that it is a very simple matter to locate it on the plan. In the photograph in Fig. 3 is given a view of the interior of the station looking up the line; it shows well the general effect of the curve. One objection to a curved station, from a traffic manager's point of view, is that a very long train would not always be visible throughout its length from the guard's brakevan, and thus an extra hand would be required to start the train. Where possible, however, stations of all classes are built on the straight. The span of the Bristol roof is a hundred and twenty-five feet, and consists of a series of trussed arched ribs. As the walls of the station are not intended to take their thrust, the ribs are tied together by tie-rods extending from the one springing to the other. Each tie consists of three parts, one central horizontal member, and two inclined side members. Light bracing is introduced between the ribs and the tie-rods, to prevent the sagging of the latter, but the ribs themselves are independent of any assistance from them. The trussing between the flanges is of the usual panel type, and, though one of the diagonal bars would be redundant under a purely static and uniformly-distributed load, yet, when it is borne in mind that the effect of high winds, and sometimes of storms, is often felt first on one side of a roof and then on the other, the necessity for counterbracing the web of the panels is at once apparent. Although not so severely scientific in design, to a professional eye, as the long-panel N type, the double intersecting diagonals in the arched ribs of the Bristol roof have a light and pleasing effect. The other system has a more or less lop-sided appearance, and always appears to want the additional diagonal member, which is inserted in all instances in two or three of the panels at the crown. A skeleton elevation of the roof of the Bristol joint station is given in Fig. 4.

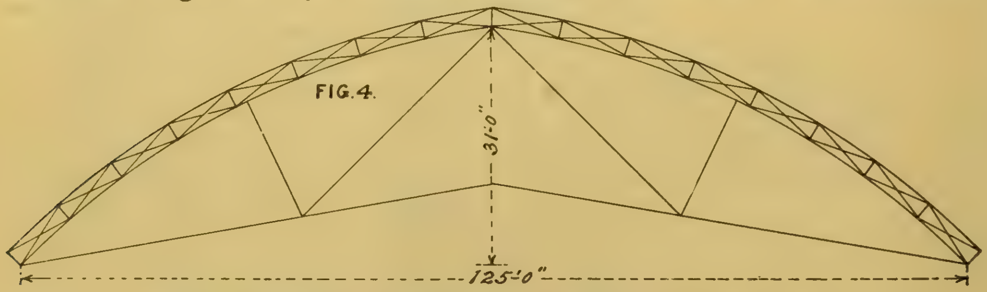


FIG. 4. SKELETON ELEVATION OF BRISTOL STATION ROOF.

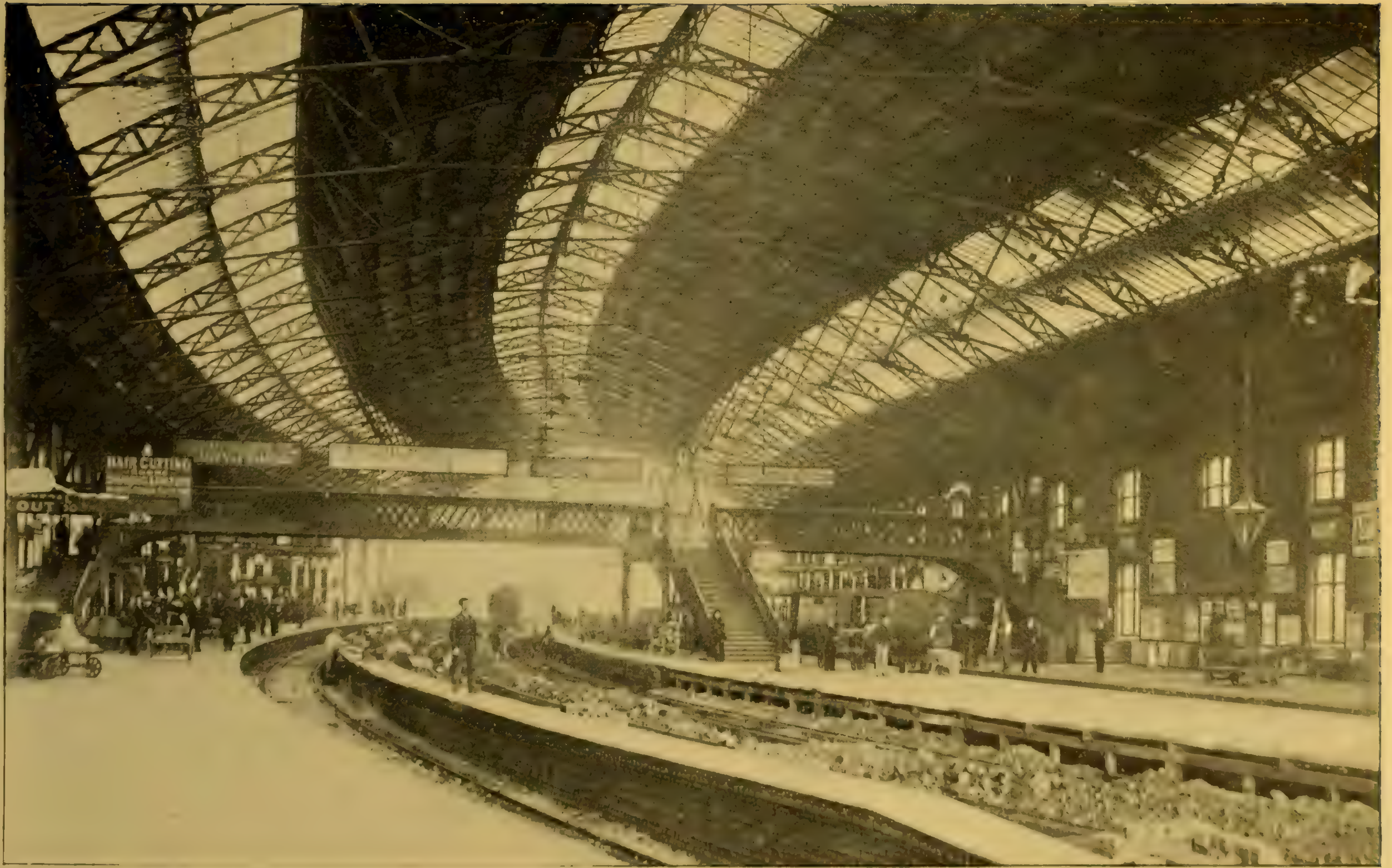
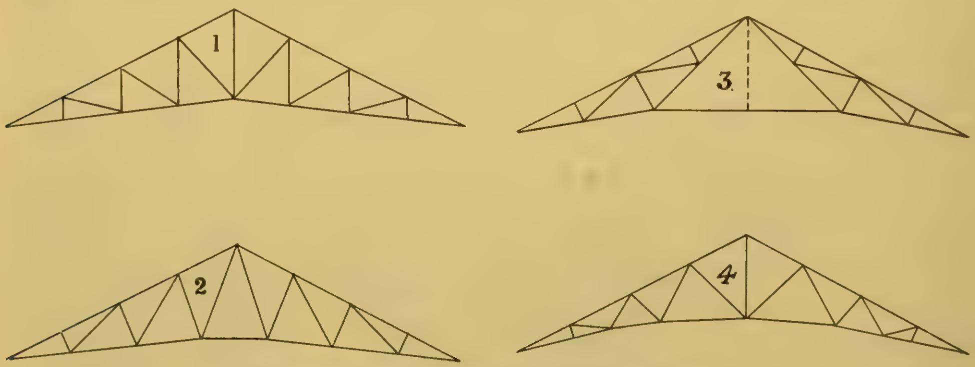


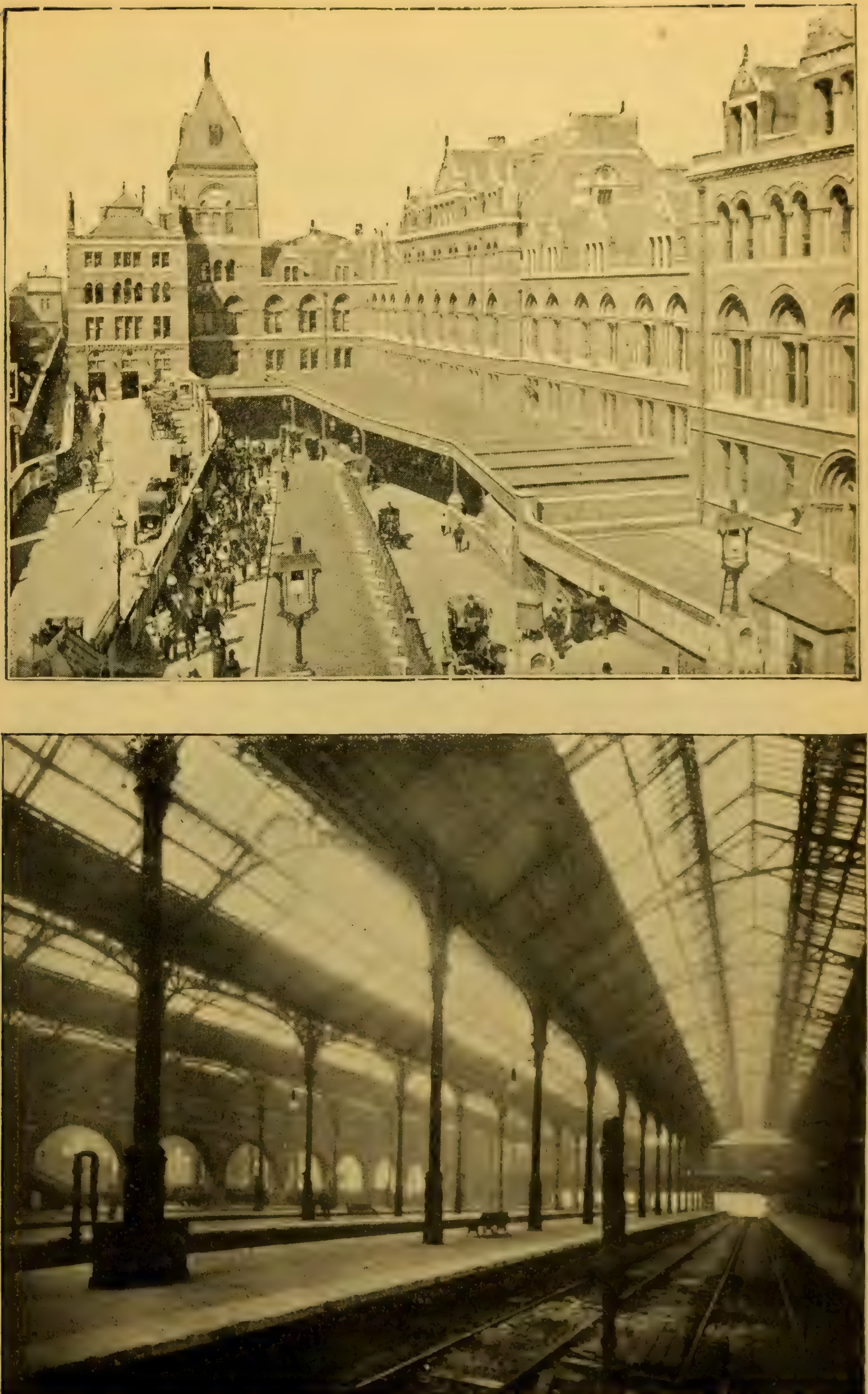
FIG. 3. THE INTERIOR OF THE BRISTOL STATION, SHOWING THE CONSTRUCTION ON A CURVE.

Attached to the passenger station, and at a short distance from it, are the locomotive, goods, and carriage sheds, coal stages and yards, and all the numerous houses, offices, buildings, and installations belonging to the *entourage* of great passenger stations and locomotive depots. The station is lighted on the intermediate principle, which diffuses the light more uniformly throughout the building than does either of the two others frequently adopted. The foot bridge can be reached by three flights of stairs, one on the up and one on the down platform of the Great Western, and the third on the Midland arrival and interchange platform. By means of the last platform and the foot bridge passengers by the Midland can find their way to the departure platform of the trains for South Wales.

The many forms of roof principals adopted for railway stations, with some exceptions, can be reduced to a small number of primary types or systems. Considering those built of either wrought iron or steel (in modern practice the latter material has almost entirely ousted the other) the principals themselves may be classed as those which resemble the ordinary rafter type and those which assume the arch form. In another roof, of a somewhat peculiar class, the principals are replaced by horizontal girders supporting the roof-covering itself, which is carried upon rafter principals of comparatively small span. This roof is also termed the ridge and furrow type. It has been adopted for the Bridge street station in Glasgow. A great railway station has not necessarily a roof of single span proportionate to the magnitude of the structure. In fact, several great English stations are roofed in by a succession of principals, whose dimensions are by no means commensurate either with the total area covered or with the importance of the station itself. In accordance with the title of this article, mention is omitted of all roof-designs suitable only for spans of less than sixty feet. Any of the rafter-shaped trusses, 1, 2, and 3, may be used for spans up to a hundred feet. Their general dimensions are the same, and they vary only in the manner in which the



ELEMENTARY FORMS OF ROOF TRUSSES.



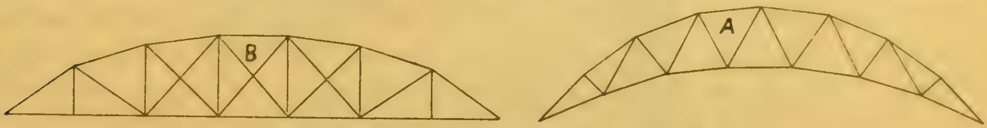
EXTERIOR AND PART OF THE INTERIOR OF LIVERPOOL STREET STATION, THE LONDON TERMINUS OF THE GREAT EASTERN RAILWAY.

bracing is arranged. Whether one design, *cæteris paribus*, is more economical than another is doubtful, but the preference might be given to truss 3. It is known as the French truss, and may be used for rather longer spans than those which either of the other two examples allows. Neglecting the lengths of the rafters and the tie-rod connecting their extremities, or—what amounts to the same—regarding them as quantities common to all three designs, the total length of bracing in forms 1, 2, and 3 are as 3.7, 3.25, and 2.8.

Sometimes the tie is arched, as in example 4, which arrangement allows additional headway to be obtained at the centre of the span, and tones down the rather stiff appearance of the three other specimens of the rafter or rectilineal system. One more example, 5, the shape of which resembles the old timber queen-post roof, completes the list of this class of roofs. When the span of a roof exceeds one hundred feet, it is more economical to adopt a semi-circular or segmental contour.

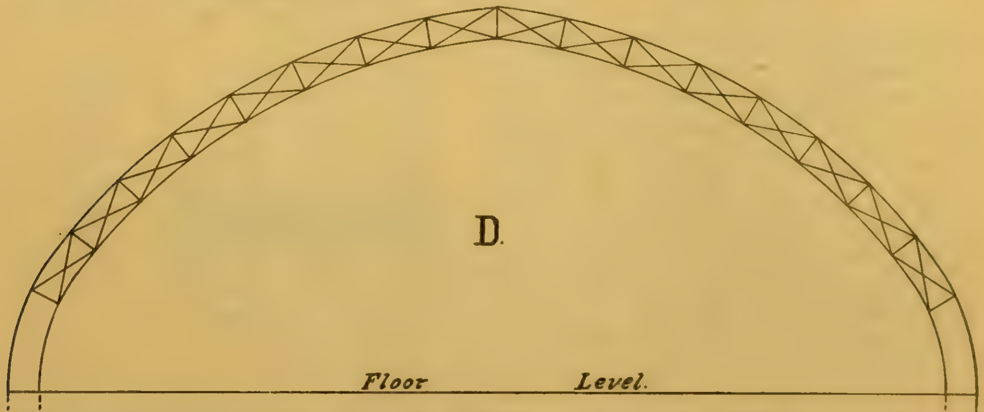
A PLATFORM IN LIVERPOOL STREET STATION.

Under the next class are included the polygonal, the bowstring, and the simple arched rib, where intermediate trussing between the arch and the tie is introduced, as in the roof of the Bristol Station, solely for the purpose stated. All the different descriptions of bracing may be used in the first two of these last-mentioned types, except the system represented in the French truss in 3. A polygonally-shaped truss, A, may have almost any description of bracing, and both the intradosal and extradosal lines may form parts of true curves. When this is the case, they are usually termed crescent, or sickle-shaped, roofs. The nearer the chord lines approach the circular, the more pleasing to the eye will be the general effect. When they depart widely from it, the truss, although a strong and useful one, becomes exceedingly unsightly, as scores upon scores of railway bridges testify.



POLYGONAL AND CRESCENT TRUSSES.

A comparison between the two patterns A and B will fully illustrate what they are intended to convey. The chief difference between the polygonal and the bowstring truss is that in the latter the upper chord is usually made part of a true curve. Either the circle or the parabola may be used, but the preference is generally given to the former, as the latter is not a graceful curve.



ARCHED ROOF, WITH HORIZONTAL TIE BELOW THE FLOOR LEVEL.

There is one other description of arched roofs, which to all appearance has no tie. It is not often used, except for very large spans, and is entirely unincumbered by any bracing of any kind between the crown and the springings. One of the most remarkable, and one of the largest existing, examples is the roof spanning the terminal station of the Midland railway at St. Pancras. The stretch from wall to wall is 240 feet, and the rise is 96 feet. The skeleton elevation, D, applies to all roofs of this character, allowing for different kinds of bracing in the depth of the arch. At Glasgow and Manchester, and in other large provincial cities and towns, this type of roof has been used for large spans of railway stations. In all large arches of this character the horizontal thrust is provided for by a strong horizontal tie running across the station underneath the level of the floor; it may support the floor and everything on it.

It must be admitted that roof arches of the D type strongly resemble tunnels, and, in spite of the open web bracing, have rather a cumbrous, cavernous appearance. In this respect the roofs of St. Enoch's Station, Glasgow, and the Central Station, Manchester, appear to greater advantage than the example at St. Pancras. Instead of the peaked-pointed crown, the curve in their case is continuous at that point, although the radii of the central and side curves are different. What more than any other feature spoils the contours of all this class of arched ribs is the sharp bend introduced at the springings; but, as the walls of the stations must be built plumb, at any rate on the inside, it is difficult to see how the objection is to be obviated. In the accompanying table is a list of some of the largest arched roofs yet constructed, in which the ribs belong to what might be truly termed the invisible tie system. The largest arched rib erected at present is that at Müngsten, in Germany, for a railway there. It is built of steel, and has a span of 660 feet. The upper and lower members of the ribs are braced together by panel trussing, but there is no tie or any intermediate bracing, as the arch is firmly secured at the springings to the abutments. The Müngsten viaduct, with its gigantic central and numerous smaller side spans, presents an unusually imposing and striking appearance.

Name of roof.	Span in feet.	Rise in feet.	Date.
Manufactures and Liberal Arts Building, Columbian Exposition, Chicago	368	206	1893
Machinery Hall, Paris Exhibition	363	149	1889
Roof of Main Hall, Lyons Exhibition	361	108	1894
Station roof at Philadelphia	301	108	1893
	259	88	1894
Station roof at Jersey City	253	90	1892
St. Pancras Railway Station	240	96	1868
Central Station, Manchester	210	84	
Anhalt Station, Berlin	205	49	
St. Enoch's Station, Glasgow	198	80	
Horticultural Buildings, Colonial Exhibition	182	91	1892

It seems to be an axiom that, the larger the site, or the greater the area, of a terminal railway station, the greater the number of tracks and platforms it can contain. As a matter of fact, the proportion is never direct, and in many instances is glaringly indirect. The absolute area, although unquestionably an important factor in the case, is not the sole consideration which dictates the methods to be

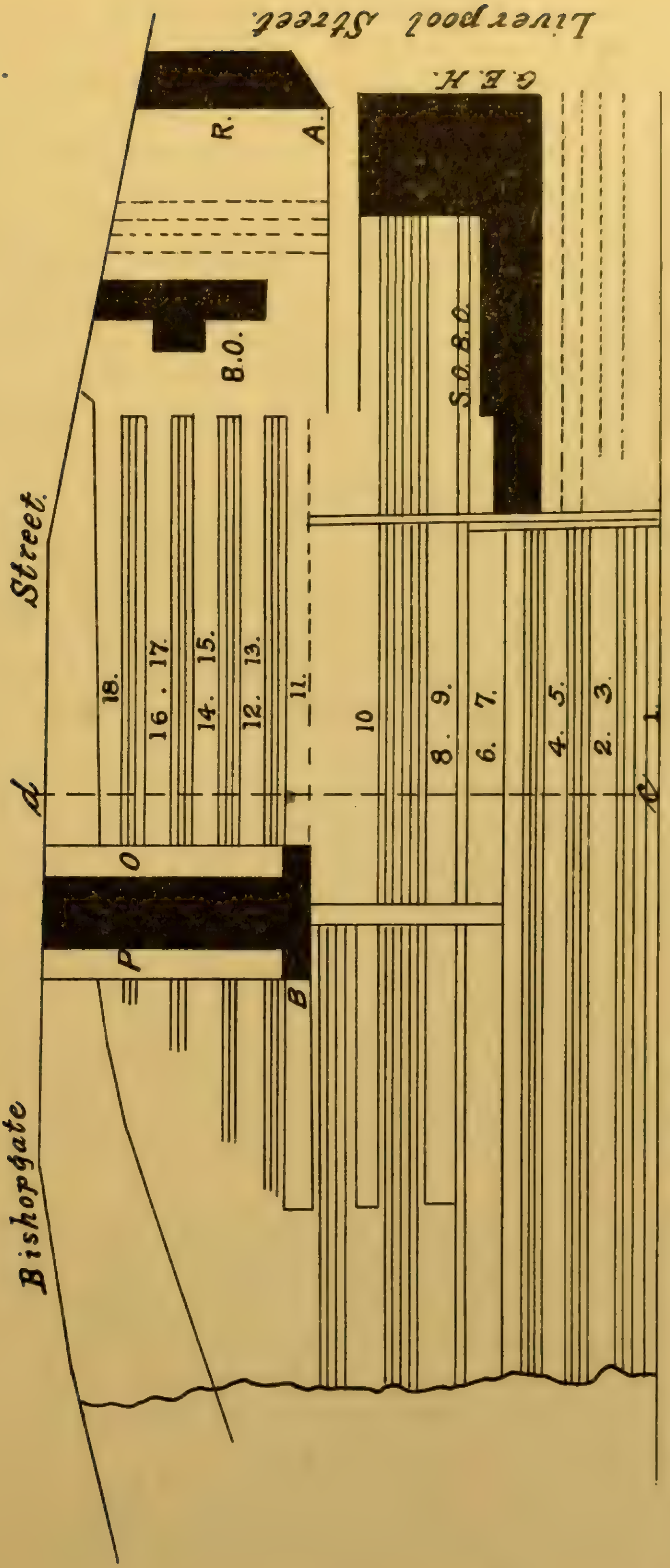


FIG. 5. BLOCK PLAN OF LIVERPOOL STREET STATION.

adopted to ensure the greatest facilities for carrying on the traffic. As with the planning—not the actual designing—of station roofs, so with the planning and setting out of tracks and platforms. The exact shape of the acquired site is a powerful element in the utilisation of its area to the best advantage. No doubt the shape of the site available must chiefly determine whether a terminal station shall be long and narrow, or short and broad, in plan. The metropolitan terminus of the Great Western, already described and illustrated, may be considered as belonging to the first class, and the Liverpool street terminus of the Great Eastern to the second, so far as relates to its breadth, which is sufficient for eighteen platforms, shown on the plan in Fig. 6. It is, however, only in the sense of purely relative proportion that it can be called "short."

Before analysing the distinguishing characteristic features of the Liverpool street station, a few particulars respecting its *raison d'être* and the great undertaking of which it is an important component part may be given. It was not until 1862 that the Eastern Counties became known as the Great Eastern railway, thus adding to its title the prefix enjoyed by two of its London neighbors, to which trio a fourth, also having its terminus in the metropolis, will soon be added, under the name of the Great Central railway. The extension of the Great Eastern from Bishopsgate into Liverpool street, together with the erection of the new and spacious station, was due to the inadequacy of the old station to meet the incessantly-increasing demands of the traffic, and to the recognition by the company of the fact that it must have a terminus nearer the city. The location of the station at Liverpool street, in the very heart of the city, is unrivalled, giving a tremendous advantage over all the other main lines. It is true that all these connect with the city—with the North London line in Broad street, for instance—and with the stations in the West end; but their headquarters remain on their primeval site. In reality, the present Great Eastern station consists of two stations,—the old one, and its extension.

Commencing at the left-hand side of the plan there are six tracks, —two each for the through, local, and suburban traffic,—which gradually bifurcate and ramify into a total of twenty alongside the various platforms 1 to 18, placed in the width of the station. It will be seen that every appliance and instrument required to work the traffic is numbered, and that the same numbers are very frequently, but not always, placed at each end of a junction.

If, in the block plan in Fig. 5, the line A B be drawn, it will divide the newer from the older part of the Liverpool street terminus, the platforms 1–10 belonging to the former and those numbered

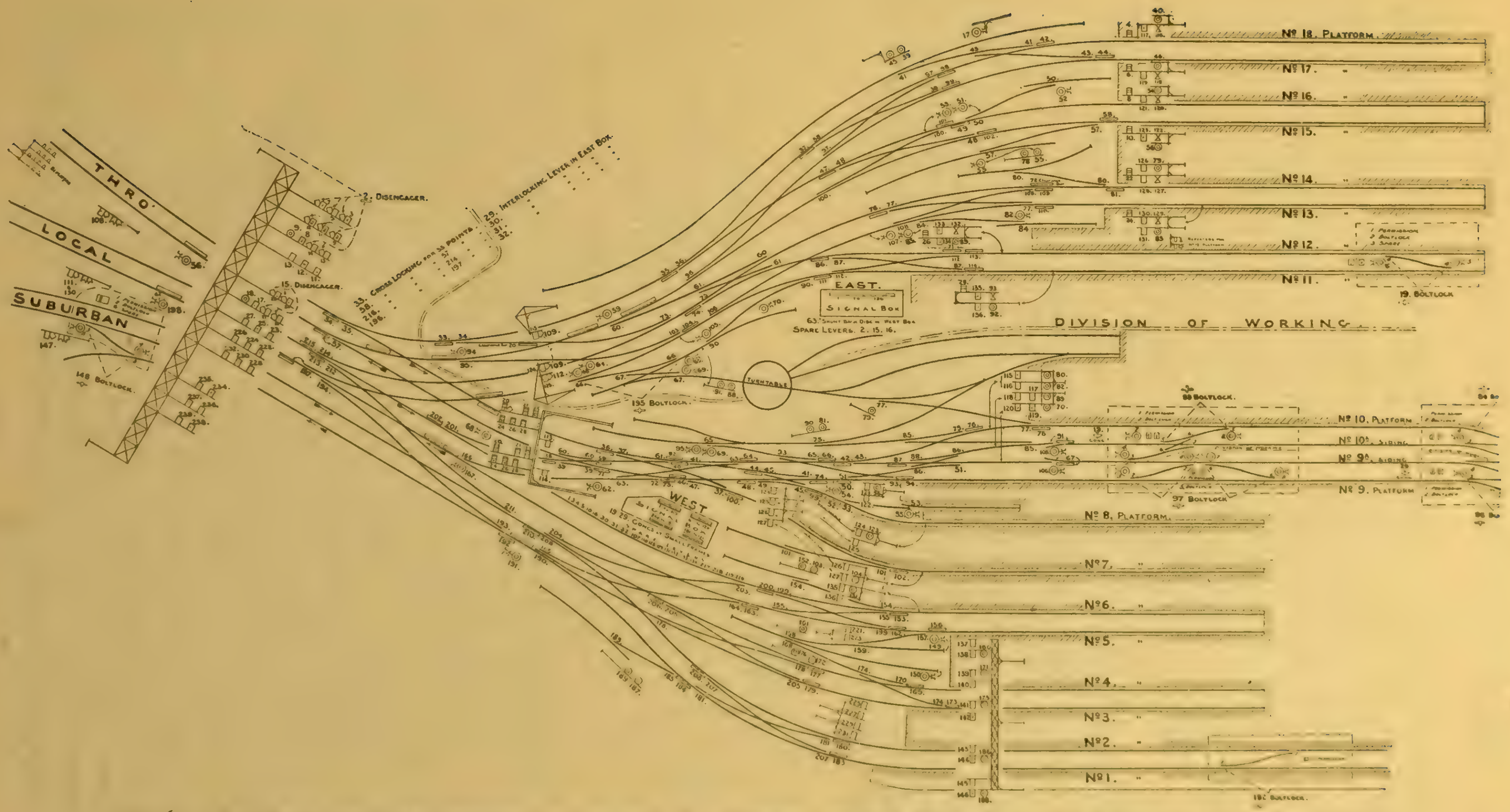


FIG. 6. PLATFORMS AND ARRANGEMENT OF TRACKS AT LIVERPOOL STREET STATION, GREAT EASTERN RAILWAY, LONDON.

11-18 to the latter. A reference to the dotted line in Fig. 5 will point out that "the division of working" follows pretty closely the same boundary, and that therefore, to some extent, the traffic arrangements are independent of one another, since all the signals on the one side of "working" line are worked from the east signal box, and those on the other from the west box. The main arrival and departure platforms are 9 and 10, and the manner in which the station buildings and general offices are situated with respect to them shows that the first part of the station was laid out on the compound principle. In the newer part, or extension, the dead-end system has been adopted, as indicated by the position of the booking and other offices. An especial feature in this terminus is the large parcel office, with an entrance in Bishopsgate street. It is built completely over the new part of the station, and communicates by a footbridge with the platforms on the opposite side. It is provided with hydraulic cranes, lifts, and all other necessary mechanical means, for lifting, lowering, and transporting the parcels, passengers, luggage, and goods which pour into it daily.

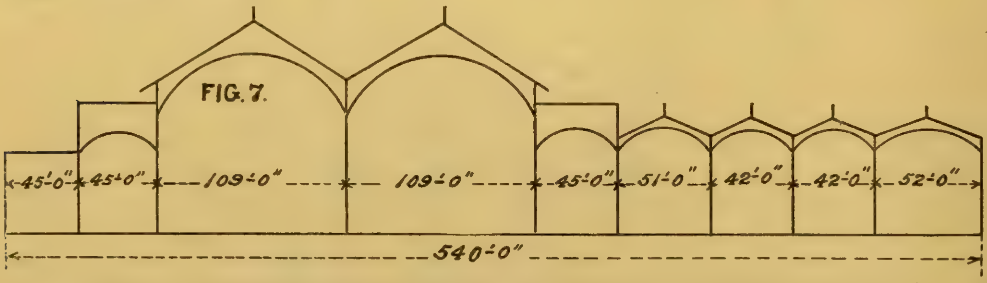


FIG. 7. SKELETON CROSS SECTION OF LIVERPOOL STREET STATION.

The skeleton cross-section, Fig. 7, along the line C D, in the block plan Fig. 5, shows at once the great breadth of the present station, and the manner in which the several spans are arranged. A noticeable feature comparatively, in the more recent construction, is that the length of the spans of the earlier part of the terminus have been just doubled. This is no doubt a considerable improvement, insomuch as it dispenses with some of the numerous columns required for the smaller spans, besides affording a greater unincumbered horizontal area, for the disposal of the tracks, for the working of the traffic, and for the comfort and convenience of passengers. In addition, the height is increased and the ventilation facilitated, and there is a sense of more space, light, and freedom of personal locomotion than can be experienced or enjoyed on platforms sheltered by roofs of small dimensions. No doubt the gradual advance made by engineers and architects, in largely augmenting the spans of both roofs and bridges, may have counted for something in determining the dimensions of the roof of the station under consideration. Probably, also, the continual demands of the traffic were the chief factor in deciding the question. A subway leads from the terminus to the Metropolitan station, M R, in Fig. 5, on the opposite side of Liverpool street.

The photograph on page 187 gives an excellent view, looking down the line towards the parcel office, of the general *mise en-scène* of the interior of the terminus. It represents the wall, pierced with arches, dividing the old from the new part of the station, the two large spans of 109 feet each, and the smaller side span of 45 feet. It is evident that the roof principals are of the trussed rafter type, and, with the exception that the main tie is more arched, are identical with the form 4, in the illustrations accompanying this article. The principals are supported on columns thirty feet apart, and are connected by three rows of purlins, upon which small intermediate trusses are fixed, which carry the roof-covering, consisting of the tee iron and sash bars for the glazing, and timber sheeting for the remainder of the structure. The columns are placed in the centre of the platforms which are perfectly free from obstructions and fixtures. Another interior view, looking in the reverse direction, is shown on page 188.

Referring again to the six normal tracks, in the plan Fig. 6, to which all those within the area of the terminus ultimately converge, it is not so difficult as it appears to trace them to their respective arrival and departure platforms, in spite of the apparently confusing array of points, crossings, junctions, and sidings. In the first place it is to be observed that the direction in which the trains travel and the tracks to which they belong are shown by the arrows placed alongside the latter. Consequently, the outer, or further, "thro" track should end alongside the arrival platform of the main line, which is numbered 10. We may disregard the breaks in the plan, where the signals are shown, and, if we follow the track we have selected, it will be found that it is perfectly continuous until it terminates at platform 18. Its direction is known to be "up," because it and the track leading to the main arrival platform effect a junction at the points numbered 35, and could not therefore run in opposite directions. It will assist the reader, in tracing the course of any particular track, if he notes, when following it to the terminus, that junctions which take off in the same direction are frequently numbered consecutively. The "thro" departure line bifurcates at "57," and may lead to platform 17 or 9. Similarly the "local" arrival trains may pull up at either 14 or 6, and those departing may leave from 11 or 5. Platforms 1 and 2 are reserved for the "suburban" lines, which do not run into the new part of the station.

All platforms may be included in one or other of two divisions, guarded and unguarded, or open and closed. By the former is meant a platform to which the public, whether passengers or not, have free access ; the latter comprises those which are closed by barriers or gates, only travellers being allowed to pass. In terminal and through stations, where the booking office and other buildings are in direct communication with the platforms, it is almost impracticable to adopt the closed system, but it is a simple matter to use it in stations with a dead end. An open platform, with its refreshment rooms, book and newspaper stalls, and other conveniences, has a certain attraction for the public, especially for the idle portion of it. In the early days of railways, it was the custom on some of the great lines, when persons went to welcome their friends, or to see them off, to give them a pass for the platform, to enable them to do so. There is also a mixed system, which is very useful on through stations, when the booking office is either above or below the platform. The access to the platform is closed by a gate, which is opened only to those possessing a ticket, but at the same time book stalls, buffets, and the usual accessories are located along the platform. Nearly all the stations on the Metropolitan railway are arranged on this system, which works well. As a rule, the great railway stations of England have both open and closed platforms. I am not aware of an instance in which there is not one or more open platforms. There is sometimes much inconvenience to passengers, when the platform is situated between a pair of tracks, on account of the possibility of entering the wrong train, and even the occasional misdirection of the enquiring traveller. The remedy of a second examination of tickets, after the passengers have entered the carriages, entails extra labor upon the officials, and is seldom resorted to. In stations with open platforms, however, the chances for confusion and mistake are far greater.

At terminal stations laid out strictly on the dead-end principle, all the offices and station buildings are arranged along it, at right angles to the tracks. This is decidedly the more modern, and the best, system, for, while it allows a certain area for outsiders to benefit by all the advantages attending a large station, it debars them from crowding on the platforms and interfering with the comfort of those who, strictly speaking, alone have a right to use them.

ESSENTIAL PRINCIPLES OF ECONOMY IN STEAM-POWER INSTALLATION.

By W. Cooper.

THE striking tendency of the age is toward the reduction of the cost of production, and, whether the thing produced be substance or force, this reduction is to be secured by an intelligent and exhaustive study of each detail which enters into the organization of the whole.

When such an analysis is applied to a power installation, it is proper to begin at the coal pile, for this is the source of the power as well as the measure of all expense. Other things being equal, the more coal burned the larger the installation becomes, and the greater the fixed, as well as the operating, expenses.

The first thing to take into consideration, in connection with the fuel problem, is: what kind of fuel will evaporate the greatest amount of water per unit of cost under the most favorable conditions? Since the water in the boiler is evaporated by the heat evolved by the combustion of the fuel, it is important that this process of combustion be made as perfect as possible, provided it does not cost more to make it perfect than would be lost by allowing it to be imperfect. For instance, it would not pay to install a mechanical stoker if the interest on its cost and the expense of its maintenance would amount to more than the saving in fuel and labor effected by its use.

The first step in investigating the fuel is to determine the amount of heat in a given quantity; the second, to ascertain what part of this heat is absorbed by the water in the boiler. The first determination is the more difficult of the two, and can be effected only by chemical analysis or calorimeter test—preferably the latter. The second is easily computed from the number of pounds of water evaporated.

If it be found that only fifty per cent. of the heat in the fuel is accounted for by the heat in the steam, the conclusion is that some of the heat is not evolved, owing to imperfect combustion, or else is lost after evolution. The question of the perfection of the combustion can be solved, with a greater or less degree of accuracy, by observation. If the heat is lost after being evolved, the fact can easily be determined by taking the temperature of the flue gases and the outside brick work, etc., of the boiler settings.

If combustion be perfect, all the heat should be accounted for by the three following measurements,—*viz.*, the amount radiated from the boiler and settings, the amount passing up the stack, and the amount absorbed by the water in the boiler. This last part only is doing useful work. The amount of heat radiated from the boiler and settings, except in very extreme cases in which it is easily detected, is small, and may be neglected in these calculations without introducing any great error.

The temperature of the flue gases is easily taken with a pyrometer, and should be but little above the temperature of the steam in the boiler. It is evident that the gases cannot be delivered at any lower temperature than that of the steam, but their temperature should be little higher. The only way by which any more heat can be taken from the flue gases, lowering their temperature below that of the steam, is to bring them into contact with the feed water, in some kind of a so-called economizer, after they issue from the boiler.

If, after examination, it be found that the temperature of the flue gases is but little above that of the steam,—say not more than 50° F.,—and the radiation from the boiler and settings be not excessive, and still the heat be not absorbed by the water in the boiler, there is only one source to which to attribute the difficulty, and that is imperfect combustion. The first thing to take account of is the amount of combustible taken from the ash-pit. If this be found in large quantities, the firing is not properly done, the cause possibly being bad condition of the furnace. If the amount of combustible in the ashes be small, or if there be none at all, then the fuel goes up the stack unconsumed. There are many reasons for this.

Complete burning of the coal means perfect combustion. When a chimney discharges smoke, it is evident that the combustion is not perfect. If the combustion be not perfect, it is proof positive that insufficient air has been admitted to the furnace or combustion chamber, or, if sufficient air has been admitted, that the temperature at which it mingled with the solid or gaseous fuel was not high enough for oxidation.

The usual process of burning coal in the furnace of a steam boiler involves both distillation and combustion, and at almost all times some part of the furnace is below the temperature of combustion. The fresh fuel is usually delivered to that part of the furnace to which no air can penetrate without first passing through highly-heated portions, in which the oxygen is consumed. The heat of these products of combustion, however, distills off or sets free the volatile portions of the fresh fuel, and, as there is no oxygen with which these can combine, they pass off unoxidized. In order to produce perfect combustion, the volatile portion of the coal, which is set free by the first application of heat, must be brought into that part of the furnace which is at, or above, the oxidizing temperature, and it must be mingled simultaneously with sufficient air to cause complete oxidation.

With a furnace so constructed that these results could be effected, the problem of getting the heat into the water in the boiler would be much simplified, since the efficiency of the heating surface would not be impaired by the presence of soot.

In general, if the efficiency of a steam boiler is not what it should be, the first thing to do is to find if the cheapest kind of fuel, obtainable in proper quantities and applicable to the conditions, is being used, and if it is all being burned. If this be found to be the case, there is but one question more, and that is: Does the heat of combustion get into the water in the boiler, or does it go up the chimney, or out through the brick work, or elsewhere where it is not useful? When the three conditions of cheapness, perfect combustion, and complete utilization are fulfilled in the highest degree, the highest efficiency is reached.

It is practically impossible to fulfill these conditions by hand firing, and in but few of the mechanical stokers on the market are they even approximated.

From the foregoing comparisons ideal conditions can be formulated for the boiler plant. The first of these conditions relates to the handling of the coal and the manipulation of it under the boilers. It is evident that there must be a balance between the interest on the investment in mechanical appliances and the cost of labor for hand-firing. In the stoking of coal, however, there is another factor to take into consideration. The installation of mechanical stokers reduces not only the labor item, but the fuel item as well, through the more perfect combustion which is secured. The extra plant may, however, so increase the interest and maintenance item as to overbalance the saving in labor and fuel.

If properly installed, coal-conveyors and mechanical stokers are, in a great majority of cases, an economical investment. Where the coal is of poor quality, and, in consequence, larger amounts have to be used, machinery of this character is especially likely to prove economical, because it displaces so much hand labor. On the other hand, if the coal be of very good quality, the labor of handling might not be great enough to warrant using machinery.

An arrangement of boilers which conduces to economical handling of the coal is in two rows of batteries, two boilers opposite and facing each other in each battery, with coal storage above and through the center of the building, leaving all the space above the boilers, on both sides of the coal bins, free for steam and other piping. The coal is taken by chutes from the main storage bins directly to the mechanical stokers. Under the boilers a continuous channel with a conveyor delivers the ashes into a car. In this arrangement absolutely no hand labor is required.

Now that ideal conditions for handling the coal and burning it under the boilers have been determined, and means pointed out for approximating them, the next step to be considered is the utilization of the heat of combustion.

The efficiency of a boiler should be determined on the percentage of the heat units in the coal absorbed by the water in the boiler, and not by the number of pounds of water evaporated per pound of coal. The best method for determining the heat units in the coal is by calorimeter test, as this gives the heat by actual combustion and not by intricate calculation from a chemical analysis. The calorimeter test should be continuous, and should be made under the same conditions as the boiler test. This means that it must be made on the ground, at the same time as the boiler test and for the same period.

There is but little difference in the efficiency of different types of steam boilers when properly set and equipped. The value of the calorimeter test in this connection is to determine whether or not these conditions of setting and equipment have been fulfilled. The difference in the actual value of different boilers lies in their capacity per unit of cost and maintenance. This statement means that any boiler can be made to show the maximum efficiency. The conditions of maximum efficiency are that the combustion shall be perfect, the flue gases shall escape at exactly the temperature of the steam in the boiler, the radiation factor be reduced to a minimum, and the ashes be drawn at the temperature of the entering air. When these conditions are fulfilled, one boiler will show no higher thermal efficiency than another. Any boiler can be made to meet these conditions *at some capacity*—and therein lies the chief difference in steam boilers. Their comparative capacities, at maximum efficiency per unit of cost and maintenance, measure their comparative values, other things (such as safety, etc.) being equal. This being true, the points to be determined are: what is the proper setting, and what is the capacity at which any given boiler will show the maximum efficiency?

Thus it is seen that there are but two points to consider in the selection of a steam boiler,—cost, and maintenance per horse power at the capacity at which it is guaranteed to reach the maximum efficiency. The above conclusion takes into consideration only the actual expenses,—that is, the fixed expense of interest on investment and the expense of maintenance. There may be other considerations entering into the question, which will alter the decision as to the boiler to be selected: such considerations are safety, maximum capacity or ability of the boiler to stand forcing, etc.; but these have no direct bearing on the actual question of expense. Under the item of maintenance is included cost of cleaning, repairs, and renewals, and such other operating expenses as would not be identical in all kinds of boilers. Under the item of cost must be considered the space occupied, for that enters, as a direct factor, into the cost of the building site.

The designers of steam plants usually commence to duplicate at this point, in order to provide against so-called accidents. They often spend thousands of dollars to duplicate boilers, steam piping, and engine, while they do not provide storage for fuel enough to run the plant twelve hours, even when, as is often the case, they are dependent upon a single line of railroad for their supply.

There are but few accidents in power plants. Ninety-nine per cent. of the so-called accidents can be traced to ignorance or carelessness. If a boiler bursts, it is due either to the ignorance of the men who designed it or to the carelessness of the man operating it. It is wiser to secure the margin of safety by increasing the strength of the parts than by increasing the number of parts.

Since the energy in the steam, in the form of heat, was produced by the combustion of the fuel, it follows that every unit of heat which would otherwise go to waste, that we can put into the feed water, is clear saving. There are but two sources from which waste heat can be recovered,—the flue gases, and the steam after it has partially or wholly completed its work in the engine. In considering the value of the first, the second must also be taken into consideration.

If the plant be run non-condensing, the installation of an economizer is little better than useless. If the plant be run condensing, a heater of the proper design introduced just ahead of the low-pressure cylinder gives better results than an economizer. Probably under no considerations, with the flue gases at the proper temperature, can an economizer be made to operate as efficiently as a heater using the latent heat of the steam from the engine at about atmospheric pressure. There is another method of heating the feed water in condensing plants, using the latent heat of the steam, by introducing a primary heater in the exhaust from a condenser. As the temperature of the exhaust is but little above that of the hot-well, it is evident there is not much saving to be made. Heating the feed water by steam taken from the low-pressure receiver is much more economical than pumping the water directly from the hot-well into the boiler. The reason is that steam which has performed work is again used, and all the additional work so secured is clear saving. It is possible to make a saving by using a heater between the consecutive cylinders in compound engines. By this arrangement there would be as many heaters as cylinders in non-condensing engines, and one less than the number of cylinders in condensing engines. It is common practice to take water from the hot-well and pump it through some kind of a heater, either open or closed, in which it is brought into contact with the exhaust steam from the feed pumps and the other non-condensing "steam suckers" about the plant. The heat derived from this source is usually enough to raise the temperature of the feed to a point between 150° and 180° F. The statement is often made that there is no need for any heating of the feed water beyond that secured by using the exhaust from the pumps, for this alone will raise the temperature near to the boiling point. A feed pump that will heat the water with its own exhaust is just what is *not* wanted.

A duplex steam pump requiring from one-hundred-and-fifty to four hundred pounds of steam per horse power per hour is certainly not an economical machine by which to feed a boiler, when there is an engine, running right beside it, that requires only from fifteen to twenty-five pounds. A duplex steam pump is an emergency machine, not a constant-service one. In no plant that makes any pretence to economy should a duplex steam pump be allowed, except for use when the main engines are not running.

In a condensing plant where the condenser is, as it should be, driven by an engine of economical design, the feed pumps may be conveniently run by the condenser engine. If the condenser is direct-driven from the main engine, which is better still, the feed pumps may be run in connection with the condenser or, more conveniently, driven by belt or electric motor. In no case should a duplex steam pump be used when it is possible to connect with the main engine. An electric motor makes a very convenient arrangement, since, if there is an engine running in a railway plant, there is usually current to be had.

Great care and much money are expended in many plants in making the steam piping fully duplex. Seldom, if ever, is the feed-water piping made duplex, and often it is what might be called less than single.

It is more important to make the feed-water piping duplex than it is to duplicate the steam pipe, for water-pipe connections are subject to shocks to which steam pipes are never subjected, for the obvious reason that non-compressible or inelastic fluids are more difficult to handle without shock than those which are compressible and elastic. Great care should be taken in the construction of the feed-water machinery and connections, but in no instance should it be necessary to install a full duplex system of feed-water piping.

The impurities in the water, such as the sulphates and carbonates of lime and magnesia, should be removed before the water enters the boiler. Never feed a boiler at a point requiring the water to pass over fire surface before it reaches the temperature of the steam. It is during the process of heating that the sulphates and carbonates are precipitated, and, if they are precipitated while the water is in contact with a hot surface, they will form on that surface as scale of the worst kind. If, on the other hand, they are precipitated away from contact with a hot surface, they will be carried in suspension in the water and circulate with it to a greater or less extent, settling in those parts of the boiler where the circulation is less rapid, and the water consequently the coldest. It can make no possible difference to the steaming of the boiler whether the water is fed into the steam space or at the mud drum, as no more units of heat are required to bring it up to the temperature of the steam in one place than in the other.

A single connection to a boiler, properly made, is as thoroughly reliable as any part of the whole equipment. Arrange the feed pipe, as stated above, in such a manner that the cold water, (it is cold if below the temperature of the steam) will not come into contact with the hot metal surface. Put a heavy, brass-bodied check-valve, of the swinging clack or ball type, immediately inside the boiler, with another immediately outside, in series with the inside one, connected by a short XXX nipple to a heavy, iron bodied, asbestos-seated, plug cock. Then use extra-heavy iron pipe, heavy brass elbows and tees, and heavy flanged unions, *not* couplings. Each boiler is to be connected to a single header of the same size as the boiler connection, using brass elbows and tees throughout. This header is run to the feed pump.

If this header is found to be insufficient for all of the boilers, it can be supplemented by another of such a size that the combined area of the two will be sufficient; the supplementary header should be connected to the main one at two or more points, according to the number of boilers, but it need not be connected oftener than once for every two boilers. This supplementary header can be made of common pipe and fittings, and reduced in size as it advances. Each cross connection between supplementary and main header should be provided with a good gate valve, and a good gate valve should be introduced in the main header between each pair of boilers. In all of this piping, ample allowance must be made for expansion, but no expansion joints should be used.

There are two kinds of feed-water heaters, the open and closed. An open heater is one in which the water comes into direct contact with the steam; in the closed the heat of the steam is transmitted to the water by convection, the water being on one side of a metal sheet, or tube, and the steam on the other. The advantage of the open heater is that the water can be relieved of a portion of its impurities while it is being heated, as most of the carbonates and some of the sulphates are precipitated at or below 212° F. If suitable arrangements are made, the precipitated impurities can be removed. One of the disadvantages of the open heater is that it necessitates the pumping of hot water, which is troublesome if correct conditions are not secured; another disadvantage is that a portion of the oil used in the engine cylinder is liable to become entrained in the feed water and cause trouble in the boilers. If the proper oil is used, this condition does not occur in ordinary practice. The advantage of the closed heater is that the feed pump has to handle only cold water, and no oil can mingle with the feed; the disadvantage is that, if any of the impurities in the water are precipitated, they form scale on the surface of the heater, and very soon impair its efficiency. An open heater, properly constructed and manipulated, gives far more satisfactory results than a closed one. Its efficiency never becomes impaired, and its cost and maintenance are much less.

It is common practice to construct and erect feed-water heaters so that all of the exhaust steam from non-condensing engines will pass directly through them. This is obviously unnecessary, as, with the coldest feed water, not more than one-sixth part of the steam will be condensed. In a closed heater it is a positive disadvantage, as it necessitates the use of a heater of much greater area of opening than would otherwise be required. In an open heater this does not hold true to so great an extent, as the construction is simpler and the heat of the steam is largely taken up by the water while in the form of spray, which offers very little resistance to the passage of the steam.

There is a cardinal principle that is often lost sight of in steam engineering. Steam cannot be cooled down, or the temperature of steam cannot be lowered, without lowering the pressure, unless the steam has been superheated. This condition is, however, found frequently in ordinary practice, and must be taken account of, as it is a source of considerable loss. In the case of an engine with steam-jacketed cylinders and receivers and a large amount of free expansion at the exhaust there may be a good many degrees of superheat. Allowing the steam to be exhausted from the engine superheated, and then introducing a heater especially adapted to utilize it, is on a parallel with allowing the flue gases to escape at a high temperature and installing an economizer to save that waste.

In considering the question of feed-water heaters it must be assumed that the steam is simply saturated. By saturated steam is meant steam the temperature of which corresponds to the pressure it would have if in contact with water, and not steam that is "saturated with water," or wet steam in any of its various stages of "saturation." Therefore, if the steam be in such a condition that, if heat be taken from it, some of it will be condensed, it is necessary only to keep the heater full of steam to maintain the maximum obtainable temperature.

Feed-water heaters for non-condensing engines should always be erected with a by-pass, of sufficient area to carry all the exhaust steam, provided with a valve by which the flow of steam through the heater can be regulated to suit the amount of water passing. This arrangement also enables the heater to be cleaned while the engine is running. Feed-water heaters arranged in this manner become practically what are known as vacuum feed-water heaters, or purifiers, except that in that class of heater no provision is made for allowing any of the steam to pass through the heater, all that enters being condensed by the feed water.

The so-called vacuum heaters are simply closed chambers, connected to the exhaust pipe, and the vacuum is that necessary to overcome the resistance to passage of the steam from the exhaust pipe to the heater. If the apparatus be properly erected, this resistance is very small. This class of heaters may be either open or closed, and can have no possible advantage over any other class of these two types in point of principle of action. The claim is made that the impurities in the water separate more readily in a vacuum than under pressure. The fact is that, for purifying the water, a heater under atmospheric pressure is as much better than a vacuum heater as the temperature in it is higher, and a live-steam purifier is as much better than an atmospheric-pressure heater as the temperature in it is higher, for the reason that the impurities precipitate more and more completely as the temperature goes higher.

As before stated, the prime office of a feed-water heater is to heat the feed water. A heater that does not do this is a failure to just the extent that it fails to attain the maximum temperature. This may be due to either or both of two reasons: the extent of surface may be insufficient, or the surface may have become inoperative. It is often found in closed heaters that they heat well when new, but soon fall off in efficiency; this is due to the surface becoming coated with scale precipitated from the water,—a condition that should not be allowed to exist. In the selection of a feed-water heater there are two points to be considered: (1) the water must be heated; (2) the water must be freed of all the impurities that will precipitate at the temperature to which it is heated. A feed-water heater that does not fulfill these conditions, to within a very small per cent. of the possible, should not be retained; for nowhere else in the whole plant can so large a saving be made, by the same expenditure of money, as in the utilization of the latent heat of exhaust steam. Therefore, the heater that will fulfill these conditions at the minimum expense for interest and maintenance is the heater to select. It often happens that a heater does not reach its minimum efficiency until it has been in service for a considerable length of time, and any test made to determine its efficiency soon after its installation is liable to be misleading. There is another condition that must be fulfilled, which goes without saying—the heater must not produce any back pressure on the engine piston. In order that a feed-water heater may heat the water to the temperature of the steam, the transmission of the heat from the steam to the water must be perfect; that is, the resistance to this transmission must be zero. This is a very difficult point to reach, and can only be approximated in a closed heater by having a large extent of surface and keeping that surface clean. In an open heater it is necessary only to divide the water into a fine spray; the heating can be done in a very small space. A closed heater is analogous to a steam boiler, the steam taking the place of the flue gases the heat of which is to be transmitted to the water, and is subject to the same conditions. In order that the temperature of the flue gases or the steam may be brought down to that of the water, the extent of surface must be very great, and, before this balance is arrived at, a point is reached where an increase in the extent of the surface means a loss, on account of the destruction of the balance between the saving made and the interest on the necessary investment.

EFFECTIVE SYSTEMS OF FINDING AND KEEPING SHOP COSTS.

By Henry Roland.

HITHERTO these papers have dealt chiefly with the means adopted by various factories for obtaining flat, or prime, cost, made up of the costs of material and of labor.

There are costs of factory production other than those of labor and material, and these are commonly included in the general term of "expense," as distinguished from "direct-production" costs.

In point of fact, there is no real difference between the separate component parts of the total cost of factory production and the costs of material and of labor, which are generally spoken of as making up "prime-cost" of product, are no more primal, or first, costs of production than those which go to make up the expense account.

There is, however, this difference between the material and-labor cost of factory production and the other elements which go to make up the total cost: the material-and-labor costs are current items, and must be paid for, in cash, at frequent set intervals, while many of the items commonly carried to the expense account arise from permanent investments of capital, and do not involve the disbursement of monies at any set time. Hence, as it is an innate fallacy of the human mind to ignore obligations grown old, it is not uncommon to find systems of factory accounting which fail to recognize some of the first-made elements of factory expense. Thus, although the factory buildings are highly important, and in many cases costly, elements of factory production, some large factories wholly ignore the building in the cost accounting. Other items of magnitude are denied as proper sources of expense by some accountants, while fully recognized by others.

There is also a personal element which can, and does, lead to material discrepancies in different formations of the expense account. Labor and material are commonly held as fixed in price, for the time being, by causes beyond the control of the general manager, while the expense account is generally regarded as being diminishable through superior management; hence there is plainly visible, in some systems of shop accounting, an attempt to keep the expense account small on the books. It is hardly needful to say that the first object of a system of factory-cost accounting is to record absolutely correct information, and that evasion or subterfuge of any sort is intolerable in this connection. A factory, from an economic point of view, is indebted for every dollar of its cost, and no factory indebtedness can ever be legitimately extinguished in any way except by its own factory earnings. From this point of view a factory cannot take a gift; if, through some peculiar combination of circumstances, a manufacturing enterprise obtains its realty and buildings without cash expenditure on its own part, the interest on the original value of the realty and improvements is, nevertheless, chargeable to the expense account, since a wide economic view cannot tolerate the infringement of general rules because of abnormal special conditions. If the factory does not pay for its ground and buildings, some one else does, and interest on this outlay is justly an item of the expense of the products of that factory.

There are two objective points in cost keeping. The first is the determination of a price at which the factory production can safely be offered on the market; for this purpose, gross sums suffice. The second point sought is lessening of production costs, and, to obtain this highly desirable result, the most minute attainable subdivision of cost is demanded. Hence, in all cases, the beginner in cost keeping is inclined to open as few accounts as possible, because gross amounts will serve his first purpose of discovering a safe selling price, while the experienced cost keeper will subdivide his expense account even down to ultimate items. This may appear, at first sight, to be a mere slavish regard for minuteness of detail; it really arises from his knowledge that production expenses cannot be reduced in gross, but must be attacked in small parts. A manager cannot reduce expense by notifying his subordinates of his general desire to do so; he must point out the exact items which shall be lessened, and before he can specify any reduction, at any point, he must know all the component parts of the cost of that detail. Hence, the experienced cost keeper may divide the expense account into a hundred, or more, subordinate accounts, while the inexperienced cost keeper may keep his expense in a single account, or, at most, divide it under a very few heads.

The general factors of the expense account are, in chronological order of creation, as follows: first, the earning power of the man or men who are to be the owners of the factory; this item may vary, evidently, from the mere day wage of the artizan who starts in business for himself, with himself as sole manager and operative, up to any sum whatever, as in the case of a man having the highest qualities of business foresight and executive ability, who rises from no position or income to a yearly earning of tens of thousands or hundreds of thousands of dollars. After the master comes the shop; the interest on the investment of cash, or credit, in realty and buildings becomes a charge to the expense account, together with taxes, assessments, a certain percentage for deterioration, and the various maintenance items pertaining to the structural property used as the factory. Then follows the plant, or equipment, item, which creates another series of interest, depreciation, and up-keep items chargeable to the expense account. Then follow lighting, heating, watching, insurance, and so on—all of the expense account so far going directly to provide a suitable theatre for the exertions of the workmen, who are commonly regarded as the direct first agents of production.

The introduction of the human element into the problem of factory production involves the indefinable factor of sympathy. In dealing with material values justice alone is demanded. Hence, there is no difficulty in laying down hard and fast rules by which accurate applications of the expense account may be made, up to the point where the human element involved by the introduction of the workman appears. The factory owners are also human,—are often, in point of fact, deserving of sympathy and consideration,—but they are free agents, potentates, men of might and substance; hence they, too, may, as factory owners, be held as rightfully demanding justice only, the same as the capital which they use or the factory products which they create.

Not so with the workman. We may number our artizan, mark him and tag him, and rank him in shop accounting with the insensible agents of factory production; but all of this will not do. We feel that he is human—a creature of hopes and fears, joys and sorrows, not to be safely, or justly, or wisely, classed with the inanimate engines of production which the factory employs. The workman must have sympathy, and sympathy is not a generally recognised commercial element; yet sympathy for the workman very often successfully opposes the dictates of the expense account.

It is not the intention of the writer to formulate any theory, or enter into any argument; still less is it the intention to print a merely superficial view of the expense account such as is involved in the marrowless statement how and when the items of the expense account are created. The manufacturer is interested in the reduction of the expense account, and in having this expense account, which he must in all cases pay himself, paid back to him by his customers.

To make my meaning unmistakable, the following commonly-accepted industrial definitions are given:

Labor: animal effort. All labor, no matter by what animal performed, is both muscular and mental, proceeds from volition, and must be recompensed by sustenance if it is to be continued. In general, continuance is implied in and by the words industry, industrial business, work, and labor.

Laborer, or workman ; one whose recompense is measured by the time-duration of his muscular effect ; one who directs his own animal effort only, as distinguished from one who directs and recompenses the animal efforts of others.

The distinctive feature of labor or work, as compared with all other things of value, is evanescence. Labor recompense and labor value depend upon a time-duration of effort, and are wholly lost if the labor is not performed from minute to minute as time passes. The flight of time is unchangeable ; hence labor is the most certainly perishable of all perishable values. The laborer must always form the undermost element of the industrial structure—governing nothing, dominated by everything, because he is dependent for the continuation of existence on the sale of a thingwhich is forever lost if not sold from minute to minute.

Between the workman and the factory there is always an unwritten, but fully acknowledged, contract of good and faithful service on the part of artizan, and of continued employment on the part of the factory. The factory is willing to take a boy at an early age as an apprentice, teach him the trade, and continue to furnish him employment during all of his life. This of course includes the natural perpetuation of the workman by reproduction, and thus makes the factory the support and dependence of the workman and those dependent upon him. The married workman is more "reliable" than the unmarried, and the family is encouraged by the wise factory manager. The factory which, from any cause, cannot furnish employment for its workmen takes the ignominious position of an industrial bankrupt. Nothing can be more humiliating to a manager than the statement to a satisfactory workman that there is no longer work to keep him busy, and that the workman must either find employment elsewhere, or must remain idle until the factory obtains more orders.

Money : concrete labor, or labor transmuted into a tangible and permanent form, which may be handled, transferred, exchanged, and stored without extinction and without regard to the passage of time. Nothing except labor can produce money, and the labor duration required to produce money is invariably the measure of the value of the money so produced. Gold is the most suitable substance yet discovered for use as money, because its rarity makes constant for short periods of time the total labor needful to obtain an ounce of gold, or, in other words, makes sudden fluctuations in the value of an ounce of gold impossible. The fact that gold is constantly becoming cheaper is of no practical importance. because the change is so gradual that we have time to adjust the machinery of trade to the diminution of the labor-value of the gold ounce.

Admitting that money is concrete labor, it must of course have an earning power, as labor has, in addition to its peculiar attribute of imperishability; it is consequently master of everything by virtue of its immortal power of earning, precisely as labor is the servant of everything because it dies from instant to instant and lives only in the inappreciable fraction of duration which forms present time.

Capital: accumulated labor.

Industrial capital: accumulated labor engaged, at least partly, in the recompensing of labor for its time duration.

Factory: a building erected by capital for use in the production of some article for sale in the open market, in competition with similar articles produced by other factories.

Factory plant: everything placed in the factory building to assist labor in the production of salable output.

Accepting these definitions, which are those sanctioned by all recognized authorities on factory economics, it follows at once that no investment of industrial capital can be neglected in the expense account, because money never loses its power of earning. The production-expense account is made up of interest, taxes, and assessments on realty, insurance, interest, and depreciation on plant, all non-productive factory labor, and, in short, every outlay caused by the factory, except the labor and material used directly in the production of salable articles. This is the extent of factory expense proper, and it is not uncommon practice to make a division in accounting here, transferring the finished factory product to the commercial side of the concern. This procedure simply separates the making and selling sides of the business. If no such separation is made, the factory expense includes also advertising, travelling, and good-will expenditures, and commercial book keeping—expenses which, in the divided system, are charged to the expense account of the commercial department. The expense account and the prime cost or production account must, together, include all expenditures and liabilities incurred in carrying on the business, including the earnings of owners.

Several different methods of distributing the total of the expense account are in use. The factory expense may be divided by the total cost of the productive machines forming the major part of the plant, thus giving each productive machine an individual hour rate. This method is faulty in case of an idle tool, as it leaves a part of the daily expense unaccounted for. The more common method is to divide the expense total by the total labor hours. Sometimes the total expense is divided by the total payment for productive labor, which is equal to the total labor hours multiplied by the average labor-hour rate. Where the total hours of productive labor form a factor of the expense account divisor, the quotient so obtained is an increment which must be applied to each and every hour of productive labor to obtain the total, or selling, cost of the product.

It is obvious that factory product cannot justly be sold to the consumer for anything less than the total cost, obtained by adding the proportionate share of the expense account to the material-and-labor cost, or prime cost. If the product is sold for less than total cost as thus determined, the seller is guilty of an economic crime which carries with it an immediate penalty in the form of a money loss to the seller, and a long train of contingent and following consequences of the most unfavorable description.

Experienced manufacturers are well aware of the extent of "demoralization" of trade in a certain line over the whole continent, by the eager efforts of one firm to enter new territory by selling at a lower price than can be maintained. If the firm seeking new business offers thoroughly good work with its low price, the damage worked becomes incalculable; indeed, it is not improbable that, under such conditions, a return to former prices may never be effected, although the manufacturer who was guilty of selling the good commodity at less than a fair price speedily forces himself out of the business. If, however, the new man who couples good work with a price reduction is able to continue in business and maintain the quality of his production at the reduced price, he has done no economic wrong, but has become an industrial benefactor.

A correct business transaction is not an exchange of values in which one side gains while the other side loses or merely obtains a new dollar for an old one; it is a transaction which both parties would be glad to repeat indefinitely, both having obtained fair equivalents. From this point of view, the manufacturer who sells at a price below his total cost makes a gift to the purchaser at an expense to himself exactly equal to the value of that gift, for which he will never obtain any equivalent. If this were all, the transaction would concern only the immediate principals. But it is not all; the producer who has a good plant, well managed, and sells his product below a fair price, including his own earning power, has taken a long step towards reducing the value of that product generally and placing a prosperous business on an insecure footing. Nothing could be more reprehensible from an economic standpoint.

And these assertions are beyond dispute. They are logical deductions from accurate cost-ascertaining, and are infallible.

Let us see exactly what cost keeping can tell the cost keeper and manufacturer. Suppose that the factory accounts are made up completely once in three months. The general manager then knows exactly what his product cost him in each 90 day period. This does not say that he knows exactly what the cost of this product will be for the three months to come. The future costs, if made with the same number of men in work and under the same general conditions, should be very close to the costs of the last three months.

But the business volume of many factories is dependent, to a great degree, on the season of the year, and in this case there may be a great difference in the number of men in work in succeeding quarters; the expense apportionment per hour of labor, or per average hour cost of labor, may be, and in some manufactures regularly is, only half as great in one period of three months as in that which preceded it. Clearly, in this case, the three months is too short a time period, and the whole year's transactions must be considered in establishing the averages by which the selling cost is fixed.

If this is done, a fair price for last year's production is known; but how about this year? An accurate record of past performance is of but little value, if it does not afford a guide for improvements in future action.

And here comes in the sympathetic factor. The factory can wait; its assets are not extinguished by the flight of short periods of time. Not so with the workman, whose power of earning comes, and goes away forever, with each tick of the clock. Must the workman be laid off and lose his time, because the manager is unable to find customers who will pay the average total cost of his production of the past year? The intelligent manager well knows the results of broken employment; it greatly injures the workman, who is most unlikely to use his idle time to any sort of benefit to himself; it entails high labor cost of the factory product, because of the high wages which must be paid where employment is irregular, and because, in every department of every factory, there is a strong inclination to keep valued workmen on, though there is really no work for them at the moment.

Suppose that the manager says to himself: "My expense account was $2,000 for the month of last year corresponding to this, and the expense conditions are about the same now as then. I have an inquiry which I can transform into an order by fixing a price covering flat costs and 50 per cent. of the expense which they should carry. Shall I place a figure on my tender which will bring the work to me, or shall I place my price where it really belongs, with the certainty of seeing the work go somewhere else?"

This is a problem to be resolved by subtle minds.

Suppose the manager settles it by the sole consideration of keeping his good men, his willing and valued servants, fully employed. That is the exercise of the factor of sympathy, at the cost of an economic crime on the part of the manager. The low price is named, the tender is accepted, and the factory goes merrily on, full handed.

Suppose now, in continuation of this incident, that other inquiries are received and replied to with low tenders, which are accepted, so that, by increased number of men in work, the expense due to the period of time is fully met. The manager has then absolved himself of his original economic sin, although he has possibly lowered the price of his product permanently. But what if he has thereby increased his sales, or the probability of sales, sufficiently to leave him better than he was?

A well-known law of sales declares that price reductions increase demand permanently, and it is not impossible that this sympathetic manager finds himself nothing out of pocket by his consideration for his men.

On the other hand, suppose the manager to be perfectly informed and a rigid economist, a man of purpose and determination, whose axe hews to the line, let the chips fall where they may. In this case, he makes, in answer to the first inquiry, a tender which does not obtain the order. His workmen are laid off. The following inquiry must perforce receive a similarly uncompromising tender, with the same result of loss of the order. Perhaps, in the case of a subsequent inquiry, the necessities of his workmen, now long enough out of work to have become paupers, may induce him to make tenders which secure an order, on which he can make nothing at all above flat cost, for the reason that he has nothing else to speak of in the course of production in the factory.

Of these two managers, who differ from each other only perhaps in the melting point of their sympathies for their workmen, there are many actual examples.

In the case of standard products, replies to inquiries for estimate often differ by a surprisingly small margin when coming from long-established firms of high repute. Between two such firms a very few dollars often determines the placing of an order, and the gaining of two or three successive orders may place the factory on a sound basis of profit for a considerable period of time, where either order alone would have been unsatisfactory.

Hence the extreme importance of knowing the very last dollar which, in view of all the present conditions of the factory, can be prudently deducted from the gross total of a tender. Such knowledge can be had only by detailed cost keeping. Minuteness of detail is by no means an index to the clerical labor involved in carrying out a cost-keeping system, while nothing short of minute detail can give the power of making close estimates.

THE MINING, SMELTING, AND REFINING OF NICKEL.

By Titus Ulke.

THE entire nickel-ore supply of the world, amounting to more than 100,000 tons annually, is obtained, with the exception of a few hundred tons, from just two localities—the Sudbury district of Canada and the French island colony of New Caledonia. There is a radical difference in the character of the ore mined in these two countries, the Canadian ore containing both sulphur and copper, while the Caledonian ore is free from both ; their metallurgical treatment is therefore correspondingly varied.

With Canadian ore the raw material must first be roasted ; it is then smelted to a matte, which is sometimes concentrated by bessemerizing, but is more generally treated directly by the Orford method, so as to separate its copper from its nickel, the final traces of copper being removed from the crude nickel by an electrolytic process.

In treating New Caledonian ore the ore-roasting is avoided, but sulphur, in some suitable compound, such as gypsum, must be added to form a matte during smelting, which operation is generally followed by roasting and refining in reverberatory furnaces.

I shall now endeavor to describe the general methods of mining and smelting used in each case, giving the items of production and cost and many other data of importance. Only the present practice in the metallurgy of nickel will be considered, the subject-matter being divided under the following sub-heads :

1. Nickel mining in Canada.
2. Nickel mining in New Caledonia.
3. The roasting of the Canadian ore.
4. The smelting for matte.
5. The bessemerizing of matte.
6. The Orford process, or separation-smelting.
7. Reverberatory refining (English method).
8. The wet process of refining.
9. Electrolytic refining.

The Mond process, by which six tons of nickel were produced per month, during a part of last year, at Birmingham, England, has not yet been proved a practical success, and therefore need not be described here.

1. Nickel mining in Canada.* As far back as 1856 the existence of copper and nickel in the dingy-green magnetic trap southwest of Sudbury, Canada, was already known, but the inaccessible nature of the country at that time deterred prospectors from making a very detailed examination and from staking out claims. So it was not until 1883 and 1884, when the Canadian Pacific Railway was in course of construction, that the first discoveries of any importance were made. An accident, not infrequent in newly-settled districts, led to the first important discovery. Judge McNaughton, a magistrate of Sudbury, had been lost in the woods to the west of the village, and a diligent search was at once instituted for him. One of the searching parties found the judge seated on the small eminence which marked the site of what is now known as the Murray mine. Early in 1884 the Canadian Pacific made a cutting for their main line through this small hill, about three and a half miles west of Sudbury. Dr. Selwyn carefully examined the location, and pronounced the lode exposed to be the most promising he had yet seen in Canada. Other discoveries soon followed, and the McConnell, Lady Macdonald, Stobie, Blezard, Copper Cliff, Evans, and Vermillion mines were all located. At first the wildest notions were entertained as to the extent, and the most exaggerated reports circulated as to the value, of these deposits.

Rounded hills, or ledges, of reddish brown gossan, varying from a foot to many feet in thickness and indicating the presence of the more solid and unaltered ore beneath, occur at intervals for miles in a southwesterly direction, and thus rudely conform to the strike of the rocks in the vicinity.

The nickel ore occurs in lenticular masses, chutes, and pockets, and not in veins, though in some cases these masses are connected by elongated deposits which have somewhat the appearance of veins. Faults and dislocations are met with frequently.

The Huronian system, in which the ore deposits are found, may be regarded as the oldest series of sedimentary rocks of which we have any certain knowledge. The origin of the nickel and copper is, undoubtedly, closely connected with the trap rock, which has broken through the Huronian strata, and the formation of the fissures containing these ores was, no doubt, due to the disruptive forces of the intrusion and the contraction caused by the subsequent cooling of the igneous rock matter. These fissures were, necessarily, most frequently formed along the line of contact with the cooler sedimentary strata, although, in certain cases, they were formed in the midst of the igneous mass itself. In nearly every instance, therefore, the deposits of nickel and copper occur close to the contact of the trap with the stratified rock, and they are rarely found in the trap near its junction with granite.

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* The writer has freely used the articles by D. H. Browne. R. H. Ahn, D. Levat, F. Benoit, and other authorities on nickel, and especially begs to thank Mr. H. P. McIntosh, secretary of the Canadian Copper Company, for his critical revision of this manuscript.

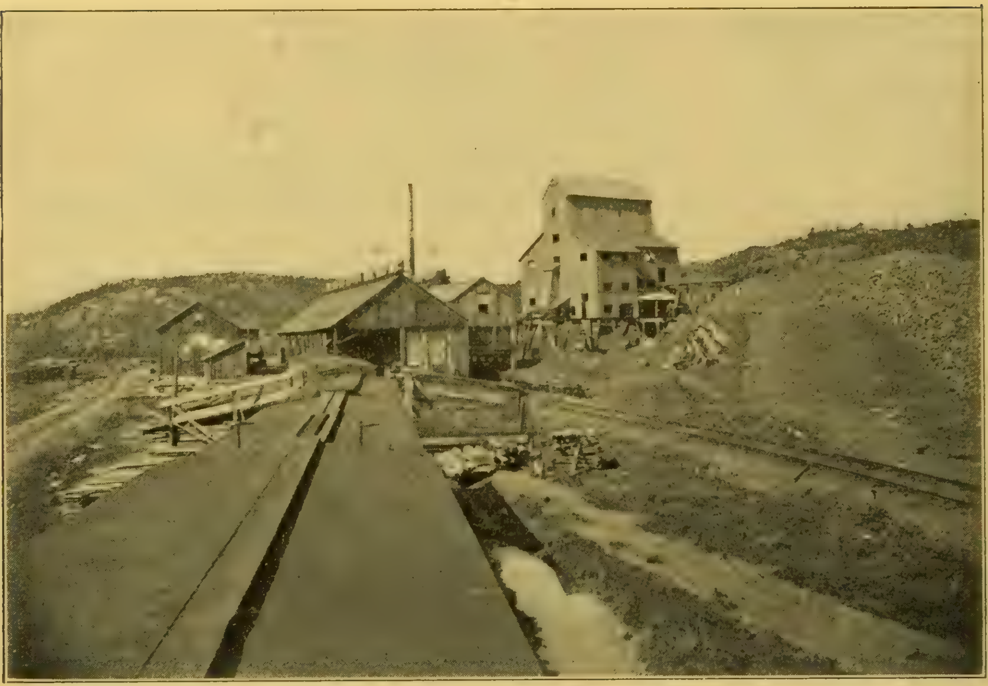
Mining is rendered somewhat difficult and uncertain at Sudbury by the absence of regular walls to the deposits and by the irregularity of the distribution of the ore, which often impregnates the enclosing rock so that there is no means of knowing exactly in what direction to drive the levels. This uncertainty, however, is more than compensated by the extent and massiveness of the deposit when found. That these deposits extend to some considerable depth is proven by the workings at the Copper Cliff, where a shaft has been sunk on a 40° slope to a depth of nearly 900 feet, at which very high-grade nickel ore is being mined.

In 1886 the Canadian Copper Company, incorporated with a subscribed capital of $2,000,000 (afterwards increased to $2,500,000) was formed to operate the Copper Cliff, Stobie, Evans, and other mines. The three mines mentioned were opened up in the latter part of the year, and, excepting an occasional stoppage during the winter months, they have been in active operation ever since. It is generally stated that the Canadian mines began to yield in 1889, when nickel matte was first shipped to the United States for refining.

The ore of the principal Sudbury mines consists of a black trap rock, usually containing impregnations or brecciated masses of nickeliferous iron sulphide (pyrrhotite) and copper iron sulphide (chalcopyrite). The chief nickel-bearing mineral is the pyrrhotite, in which nickel replaces iron in irregular proportions.

It is interesting to note that, as the mines deepened, at least up to the seventh level, the ore changed in character from a distinctively copper ore at the surface to a distinctively nickel ore in depth. The Copper Cliff mine, for example, produced, on the first level, a chalcopyrite, in which the nickel was found by accident after large shipments had been made of the ore as a copper ore alone. On the fourth and fifth levels the ore averaged about 4 per cent. copper and 4.5 per cent. nickel, while on the seventh level many stopes showed an average of only 0.5 per cent. copper to 8 per cent. and even 10 per cent. nickel. However, the levels below the seventh have brought forth ore with a larger percentage of copper than of nickel.

From the mines the ore and barren-rock are hoisted to rock-houses, where the material is roughly hand-sorted, the gangue-rock or waste being discarded. The ore, much of which is still attached to barren rock, is now crushed by Blake crushers set to a 4-inch space between jaws, and then delivered to revolving screens, the ragging or medium ore passing a 1¾-inch and the fine ore a ¾-inch opening.



COPPER CLIFF MINE YARD.

The raggings and fine ore slide directly into their respective bins, while the coarse material, not passing through the screens, falls from the latter upon washing tables. It is here passed under a spray of water, and, while being carried onward by the jerking motion of the tables, is rapidly sorted by boys, who pick out any pieces which contain nickel or copper and throw these into bins, while the waste rock falls from the ends of the tables into a larger hopper, from which it is loaded into cars.

The following analysis represents the composition of an average month's output of ore from the Copper Cliff, Evans, and Stobie mines: nickel, 2.5 per cent. to 5.5 per cent.; copper, 1.5 per cent. to 4.5 per cent.; silica, 12 per cent. to 24 per cent.; iron, 35 per cent. to 45 per cent.; sulphur, 18 per cent. to 26 per cent.; alumina, 3 per cent. to 8 per cent.; lime, 2 per cent.; magnesia, 1 per cent. to 1.5 per cent.; besides oxygen, traces of phosphorus, manganese, and moisture. The fines show a higher average metallic value than does the ragging or coarse stuff. The material is now ready to be shipped to the smelting works, to be roasted and smelted into matte. The average cost of mining one ton of ore in Sudbury is said to be about $5.

2. Nickel mining in New Caledonia. The nickel belt of New Caledonia extends for many miles, principally along the east coast of this remarkable island. Some of the richest nickel mines in the world have been developed there, the average ore extracted being higher in

grade than the average Canadian ore. The New Caledonian nickel-bearing mineral—a brilliant green hydrated silicate of magnesia and nickel, called Garnierite—was discovered in 1867, but its occurrence in sufficient amount to be of commercial value was not ascertained until 1874. It is found in fissures in serpentine, and often occupies basins and cavities in this rock at, or near to, its contact with red clay. Evidently the mineral was deposited by percolating waters in the veins or concretionary masses in which it occurs.

The lodes containing the nickel ore vary much in size, the maximum width being about twenty-five feet; but in some cases the whole of the rock is filled with small veins of the mineral, so that it may be worked as a whole up to a width of nearly two hundred and fifty feet. Only the larger veins in the hard rock are worked by underground mining, as this is rendered difficult by the irregularity of the vein walls, which are easily lost. By far the greater number of the mines are worked therefore as open cuts.

In vein mining inclines are sunk on the lodes and are connected by levels, the ore being stoped from below toward the surface and the waste dropped behind. A queer spectacle is presented by the Caucasians, Mongolians, Malavs, and Papuans working side by side in

HOISTING WORKS AND ROCK HOUSE, COPPER CLIFF.

the mines and open cuts. The actual mining is performed by a few Englishmen, who are paid from $1.20 to $1.80 per day, Kanakas, who are given their board and four dollars per month, and Annamite and Tonkese prisoners, galley slaves, and convicts obtained by contract from the French government. The best workmen are said to be the freed convicts, who earn from $1 to $1.20 per day.

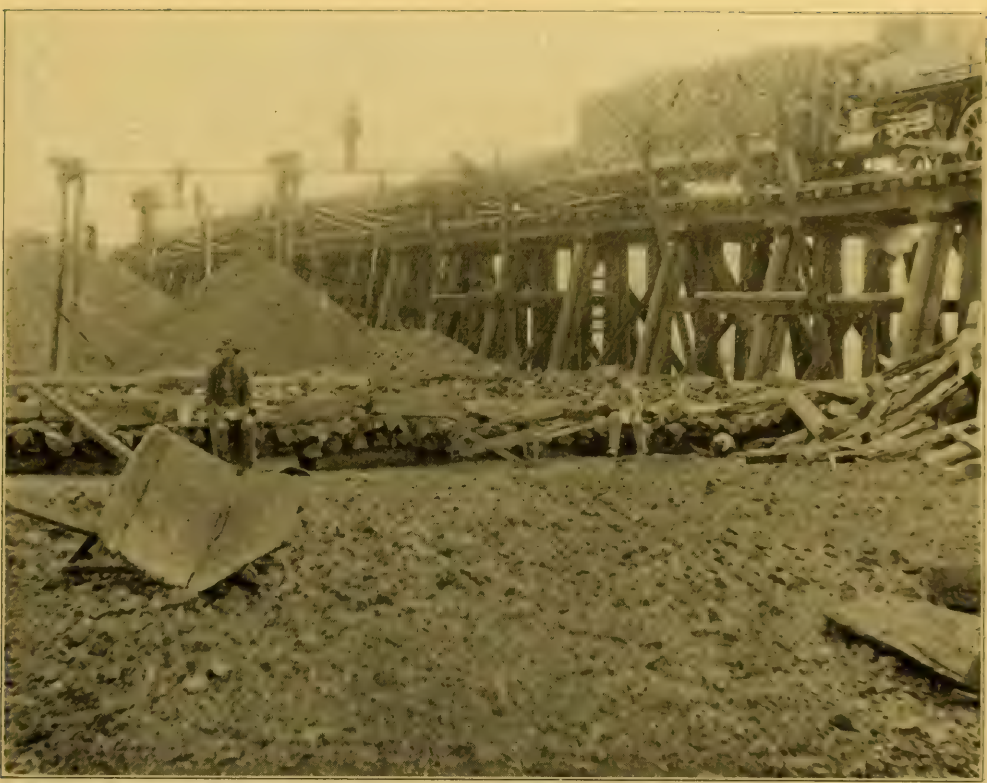
The cost of mining the New Caledonian ore varies from $3 to $8 per ton, according to the position and condition of the mines, some of which are situated high up in the mountains, while the cost of transporting the ore from the mine to the port of shipment ranges from 10 cents to $2 per ton. Ore containing from 7.5 per cent. to 8.5 per cent. nickel delivered at shipping port was valued at $21, and ore with 9.5 per cent. to 10.5 per cent. nickel at $25 per ton in 1890. The freight from Nouméa to Havre, France, is about $8 per ton of ore, having been $10 before the company "Le Nickel" had its own ships.

There are two companies operating in New Caledonia, "Le Nickel" and the "Société d'Exploitation des Mines de Nickel," the latter working a few mines belonging to the former. Besides these there are several smaller mining enterprises. Le Nickel has smelting works at Havre, and buys nearly all the ore mined in New Caledonia. This company has acquired large tracts of mineral land on the island, but is working only about a thousand hectares, from which, however, it is claimed, it earned a net profit of more than $1,200,000 in 1891, with a capital stock of only $2,500,000.

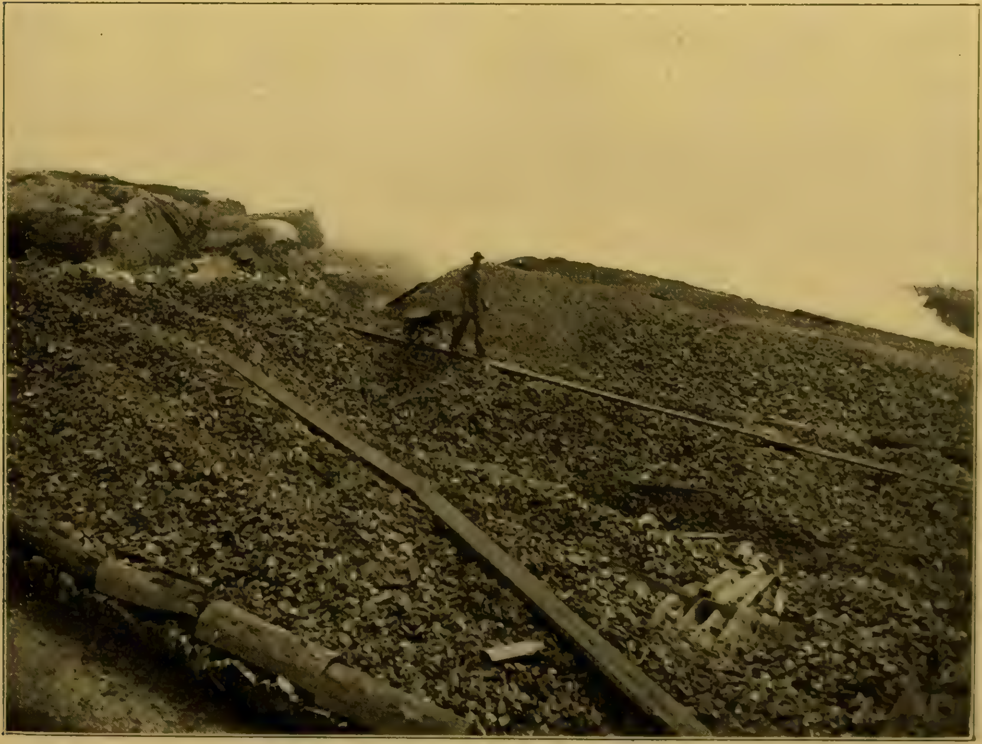
The principal mining districts are Thio, Nakety, Canala, and Kouaoua on the east coast, and Dumbea, Paouea, and Koniambo on the west coast. All the mines of Le Nickel lie in the Thio district. In 1890–91 the company extracted fully 33,000 tons of ore averaging 10 per cent. nickel, and in 1892 and in 1893 respectively, it exported ore containing the equivalent of about 600 and 1,000 tons of nickel.

It is understood that little has been done at the mines since the great storm in the spring of 1894, which destroyed a number of the company's buildings and other works, and that the company has limited itself during most of the time since to working up its accumulated stocks of ore in Europe and in New Caledonia. The company has undoubtedly felt severely the sharp competition of the Canadian metal, which could be put on the market at lower prices than its own product.

3. The roasting of the Canadian ore. In the roast yard of the smelter at the Copper Cliff, space is provided for roasting about a quarter of a million tons of ore per year. The Canadian Copper Com-



ROAST HEAPS AT THE COPPER CLIFF MINE.



BUILDING A ROAST HEAP.

pany has usually about 50,000 or 60,000 tons of roasted ore on hand ahead of the smelter. For roasting the raw ore, the ground is first leveled off, a few inches of fine ore distributed as evenly as possible over the soil, and then sticks of cord wood are placed, side by side, across both sides and ends of the rectangular area, to a height of about 18 inches. The whole interior of this can be filled in with stumps, roots, ties, or cord wood, but in such a way as to form a level and solid bed for the ore to rest upon. Over all this is placed small wood and chips to fill up all interstices, care being taken to provide small canals, filled with kindlings, at intervals of eight or ten feet, leading from the outer air to the chimneys along the center of the heap. When the bed is so far arranged, the coarse ore is piled to a height of five or six feet and covered with a layer of raggings, on top of which is sometimes scattered a layer of rotten wood or chips, and then the whole heap is topped and banked at the sides with six or eight inches of fines. Each roast heap holds from 600 to 1,800 tons of ore. Only a portion of the fine ore is put on at first, the rest being shoveled on after the fire has been fairly started. About twelve hours after the firing of the heap dense fumes of sulphurous acid will be discharged. Great attention is at first paid to the pile to avoid undue local heating, which would cause partial fusion of the ore. This is prevented by the addition of more fines to the part showing too much heat. Each roast heap burns from six to ten weeks, and during the operation the sulphur is lowered from an average of 22 per cent. to about 7 per cent., the iron is in large part oxidized, and the trap rock or

BURNING ROAST HEAPS AT SUDBURY.

INTERIOR OF NICKEL-SMELTER BUILDING. THE END OF THE MATTE FLOW.

diorite is thoroughly disintegrated by the swelling and oxidation of the ore. After the ore is thoroughly roasted, it is cooled and conveyed for further treatment to the blast furnaces in the smelter. The cost of heap roasting at Sudbury is said to be forty cents per ton.

4. The smelting for matte. At the Canadian Copper Company's works at Sudbury the furnaces are of the Herreshoff pattern, of boiler iron, water jacketed, about 9 feet in height to charging door, of oval section 6 feet 6 inches by 3 feet 3 inches, with 2 inch water space, and provided with an exterior, brick lined, water-cooled forehearth or well. The capacity of each furnace is about 125 tons of ore, or 15 tons of matte, in 24 hours; three furnaces are always in operation.

The charge consists of the ore and coke, together with nickeliferous slag from the matte-smelting furnaces or bessemer converters, when these are in operation. By arranging so that the matte and slag flow out of the furnace into the forehearth as rapidly as formed they escape the influence of the blast, and thus prevent the causing of "sows" or "salamanders," as the great masses of metallic iron, which may choke up the furnace and tie up large quantities of copper and other metal, are called. The matte is tapped from the well into cast-iron conical matte pots, in which it is allowed to cool. The slag runs con-

NICKEL-SMELTER BUILDING AT SUDBURY, SHOWING SLAG ELEVATOR AND SPILLED MATTE.

tinuously over a slag lip at the top of the well, and is allowed to flow through an opening in the floor, where a powerful jet of water granulates it and carries it to the dump.

The process of smelting is very economical, the ore furnishing in itself the exact ingredients necessary for fluxing, so that, by skilful mixture of the ores, the company has avoided the necessity of putting a pound of extraneous flux into its furnaces. About 15 per cent. of Connellsville coke is used to reduce the ore to matte, or, in other words, one pound of coke makes nine-tenths of a pound of cupola matte. Thus about six tons of ore are concentrated by smelting into one ton of matte. The average grade of matte will analyse as follows: copper 20 per cent. to 25 per cent.; nickel, 18 per cent. to 23 per cent.; iron, 25 per cent. to 35 per cent.; sulphur, 20 per cent. to 30 per cent. One ton of ore is said to cost between $6 and $7 to mine, roast, and smelt, the nickel in the matte, when bought in quantities of at least 400 tons monthly, selling for about 8.75 cents per pound and the copper at 3.40 cents per pound. It is stated that the Canadian Copper Company is now under contract to deliver all

COKE SHED, SMELTER BUILDING, AND MATTE DUMP, COPPER CLIFF MINE.

BESSEMER FURNACE BUILDING AT SUDBURY.

its matte to the Orford Copper Company, so that no Canadian matte is at present on the market.

It is stated that in the treatment of New Caledonian ores at Glasgow, Havre, and Iserlohn, the ore, together with gypsum, alkali waste, or saltcake, is charged (with the necessary amount of fuel) into low, water-jacketed blast furnaces. In the smelting process the silica unites with the magnesium and part of the iron of the ore and the calcium or sodium of the gypsum or salt-cake to form a slag, while the nickel and part of the iron of the ore unite with the sulphur of the gypsum or saltcake to form a matte. The products, therefore, are a slightly-nickeliferous slag, which goes to waste, and a highly-nickeliferous matte, which must be refined. The refining operations will be described later under the heads of Bessemerizing and Reverberatory-Refining.

THE LATEST IMPROVEMENTS IN THE FRENCH LIGHTHOUSE SYSTEM.

By Jacques Boyer.

THE powerful lights along the French coast, which were described in the preceding paper, represent advances in mechanical and optical devices which find their culmination in the new Eckmühl lighthouse—a veritable masterpiece, containing the latest improvements. The name Eckmühl is given in memory of Marshal Davoust, prince of Eckmühl, because his daughter, Mme. la marquise de Blocqueville, who died in Paris on October 7, 1892, left in her will one-half the money necessary for its construction, upon the condition that it should be so named. The structure was completed and formally inaugurated on October 17, 1897.

The general arrangement of the new light consists of a bi-focal system constructed by MM. Sautter and Harlé, of Paris. It is composed of two sets, each containing four annular lens systems (Fig. 12). In other words, the dioptric and catadioptric portions have distinct foci, situated on the axis common to the carbons and the apparatus, and placed in the horizontal planes corresponding to the points of maximum incandescence of the carbons. The lower carbon is placed in the focus of the dioptric elements, this forming the

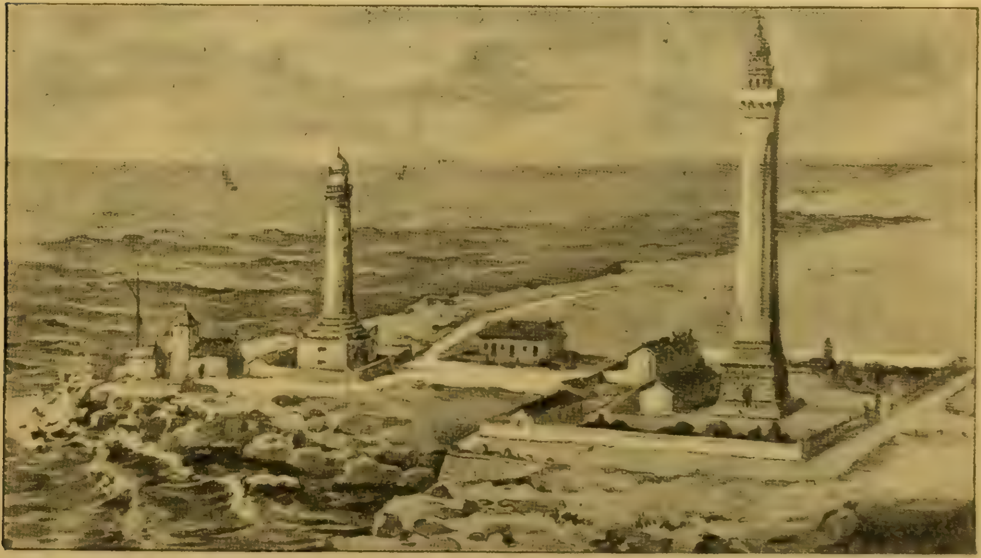


FIG. 10. PERSPECTIVE VIEW OF THE ECKMÜHL LIGHTHOUSE AND ITS SURROUNDINGS.
The bequest of the marquise de Blocqueville was 300,000 francs, and the Eckmühl lighthouse cost more than 600,000 francs.

lower focus. It therefore sends its most powerful rays over the horizon. The upper carbon is placed in a corresponding relation to the focus of the elements of total reflection, forming the upper focus. This distribution is the most advantageous, because at the horizon, where the maximum intensity is most useful, the effects of the two sets of rays are superimposed. It has even been shown experimentally that the amplitude of the combination of rays extends beyond the limits of the horizon.

The optical apparatus is carried upon a cast-iron base plate supported by a vertical shaft of wrought iron. This spindle is guided at its upper part by a bronze collar and held by a sleeve below, the end forming a pivot resting in a socket. The sleeve may be adjusted vertically by a screw in such a manner as to enable the socket to be regulated, making possible also the adjustment of the base plate to a crane serving to introduce and change the electric-light carbons.

An annular cast-iron float, immersed in a vessel containing mercury, is fixed to the vertical shaft, and, by means of adjusting screws, this float may be exactly centred in the mercury vessel. Each of the two conductors carrying the current connects with an annular trough filled with mercury and supported by an insulating material. This enables a complete electrical connection to be maintained through the mercury, notwithstanding the rotary motion. The axis of

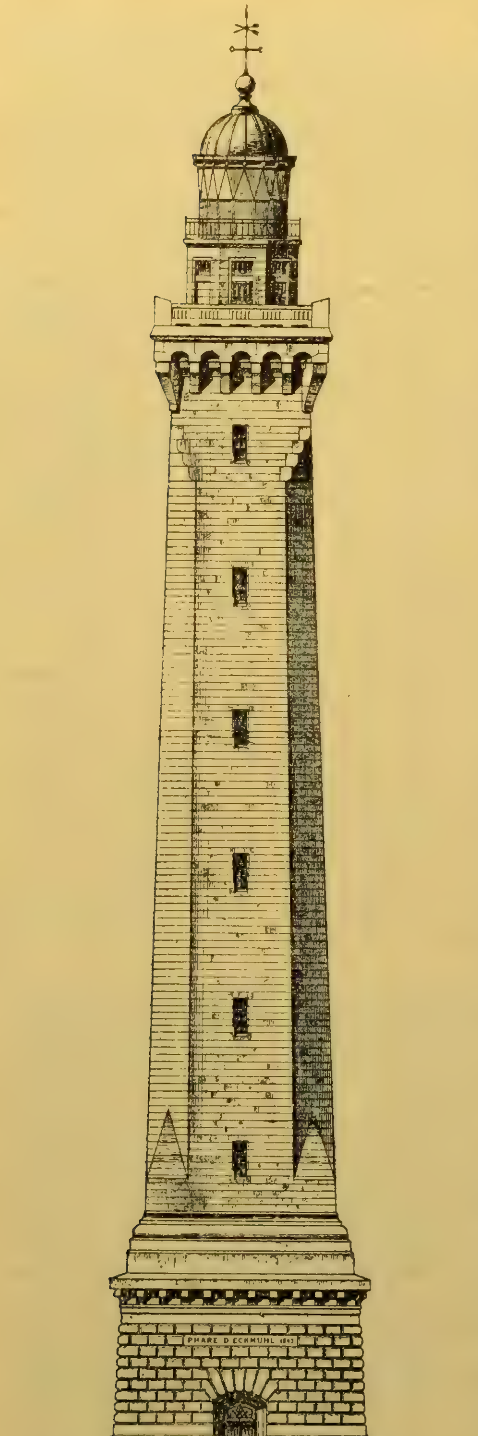


FIG. II. ELEVATION OF THE ECKMÜHL LIGHTHOUSE.

Situated on the Point of Penmarch; inaugurated on October 17, 1897.

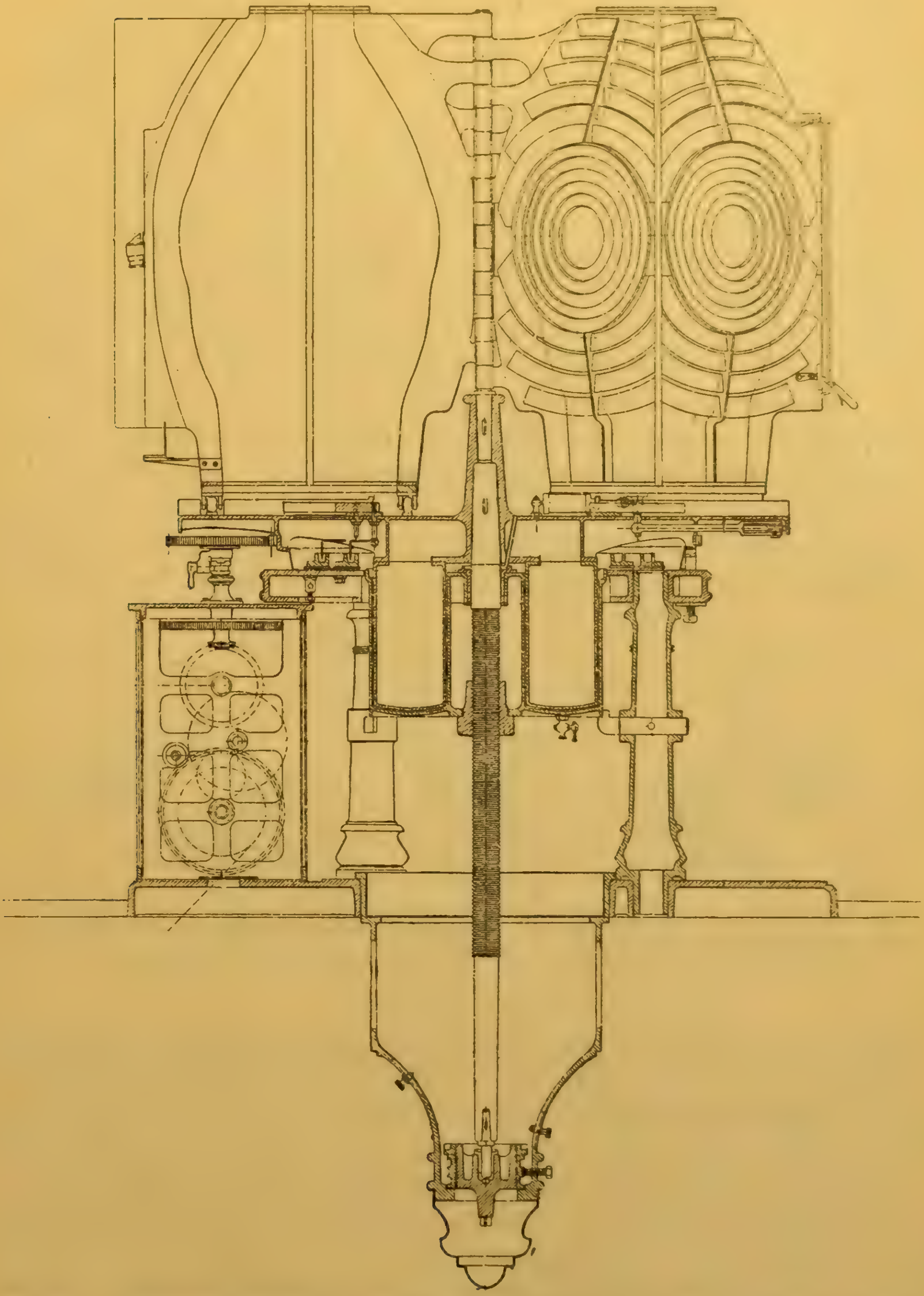


FIG. 12. VERTICAL SECTION OF THE OPTICAL APPARATUS OF THE ECKMÜHL LIGHTHOUSE, TAKEN THROUGH THE AXIS OF ROTATION.

the mercury troughs coincides with that of the shaft, and the troughs are supported by the cast-iron bearing which holds the upper part of the shaft. This support is placed upon the metallic base plate of the lantern, and by its side stands the rotating mechanism. The buoyancy of the mercury supports the weight of the moving parts, and so reduces the resistance that a complete revolution can be effected in twenty seconds by means of a comparatively small driving weight. Only one hundred and five kilogrammes of mercury are required in the float vessel, and the apparatus operates with perfect smoothness and regularity. With the old system of ball bearings, the dust from the electric-light carbons caused rapid wear, and it would have been impossible to attain the high rotative speeds required for the lightning-flash system. The two systems of lenticular panels, symmetrically placed, and having their optical axes parallel, give the same effect when rotated as if they formed but one system. The advantage of this arrangement is very marked, since it has been ascertained experimentally that, if the intensity of the voltaic arc is increased, the illuminating power is not increased proportionally. For this reason it is preferable to use two arcs. Thus with 25 amperes and 45 volts, by means of a single flash-light system, a light of 1,200,000 carcels is obtained, while with 50 amperes and the same voltage an identical system gives only 1,800,000 carcels, instead of 2,400,000. The advantage of doubling is thus clearly seen. With 50 amperes in each arc, a luminous intensity of 1,800,000 carcels, or a total of 3,600,000, is obtained, while with 100 amperes and a single arc, only about 2,300,000 carcels would be attained. These figures must be somewhat reduced in practice. The new lighthouse, which is operated in two different ways, according to the state of the atmosphere (as will be seen hereafter), has an illuminating power somewhat less. When the two arcs receive each 25 amperes, it furnishes a light of at least 1,500,000 carcels, and, when they use 50 amperes, they possess the enormous intensity of 3,000,000 carcels.

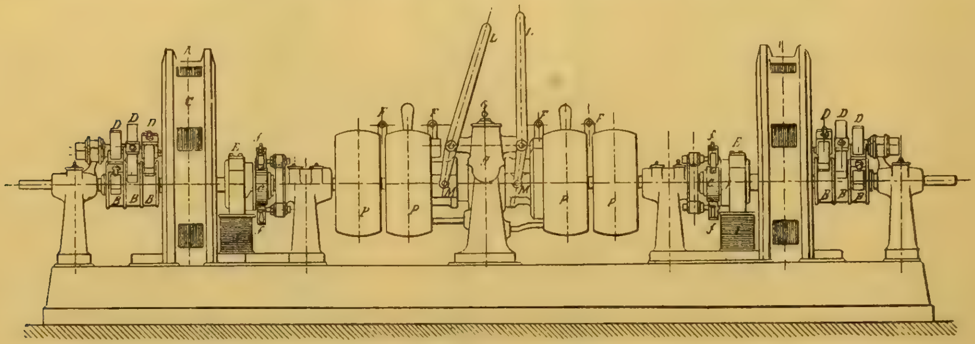


FIG. 13. CLUTCH MECHANISM OF THE ALTERNATORS AT THE ECKMÜHL LIGHTHOUSE.

Its luminous range in medium weather is then 90 kilometres, or about 49 sea miles. In hazy weather, which prevails about one day in ten, it may be seen for 19 miles.

The motive power is furnished by two strongly-built steam engines of 12 h. p., provided with an aero-condenser devised by M. Monin, which returns 75 per cent. of the water evaporated,—a matter of importance in this instance, since the lighthouse is placed where it is difficult to procure fresh water.

The two electric generators are of more interest than the engines. They have been constructed from the designs of M. Blondel, engineer of the *Ponts et Chaussées*, by the "*Société de l'Eclairage Electrique*," and are biphase alternating dynamos of the Labour type. These are well adapted for the varying service; moreover, the alternating current is more economical than the continuous current. They are driven by separate belts, at a speed of eight hundred revolutions per minute, and each generator (Fig. 13) consists of three parts: (1) the exciter E, a small continuous-current generator, composed of a field electro-magnet i, a Gramme armature j, attached to the shaft, and provided with a commutator c, and a pair of brushes ff, to collect the current generated during the revolutions; (2) the fixed inductors, or field electro-magnets, II, with cores composed of thin plates of sheet-iron clamped together by a bolted cast-iron ring, upon which the bobbins of insulated copper wire are wound (Fig. 14), these inductors having eight poles, alternately north and south, and the eight bobbins forming a single circuit supplied by the current from the exciting dynamo; (3) an armature, composed of plates of sheet iron J J (Fig. 15), attached to the shaft, and notched to receive sixteen bobbins of insulated copper wire. These bobbins compose two superimposed cir

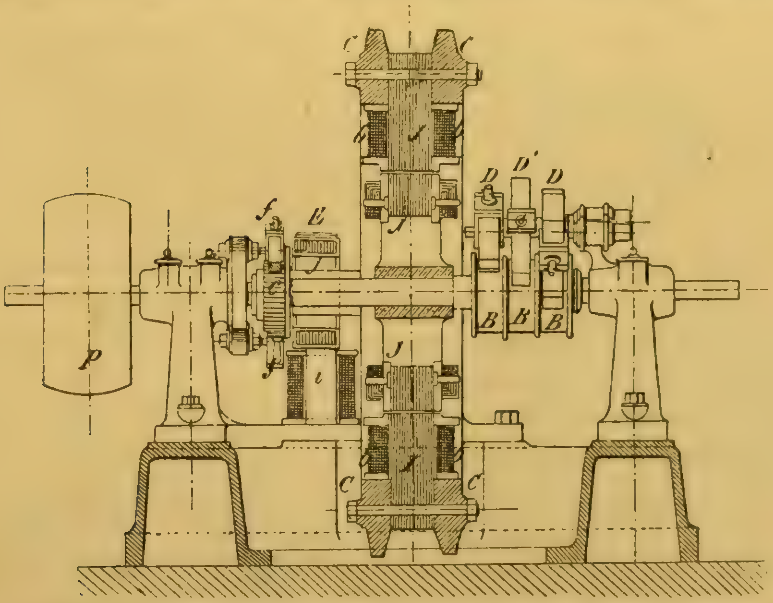


FIG. 14. LONGITUDINAL SECTION OF ALTERNATOR AT THE ECKMÜHL LIGHTHOUSE.

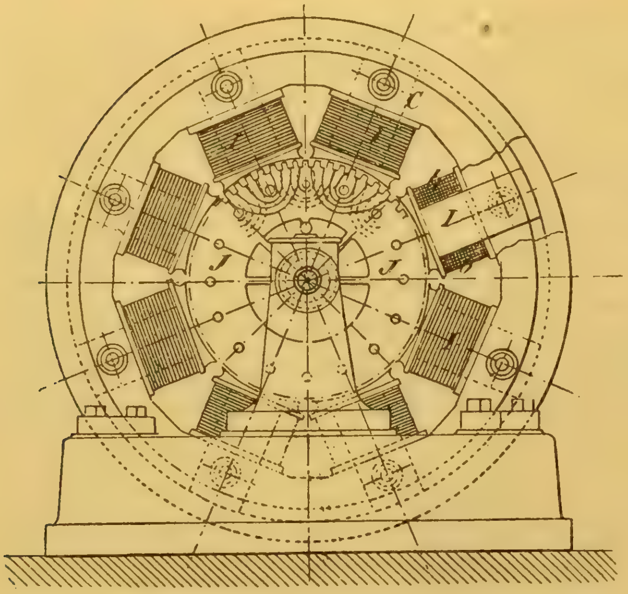


FIG. 15. ELEVATION OF ALTERNATOR AT ECKMÜHL LIGHTHOUSE.

cuits overlapping each other for half the width of the bobbin, in such a manner as to produce a biphase alternating current. The first circuit is composed of eight bobbins, the wire of which is indicated by a full line in the illustration; the second circuit consists of the remaining eight bobbins, shown in dotted lines. The rings B, B′, B″ collect the currents generated in the circuits during the revolution of the armature. Each of the first two rings belongs to one circuit, and the ring B′ is common to both. The brushes D, D′, D, which bear upon these rings, are connected to the ports on the base of the machine, and thence to conductors.

The switchboard (Fig. 16) consists of a panel upon which the conductors and controlling devices are fixed. The ports 1 to 12 of the switchboard are connected with the ports of the generators by means of insulated conductors, and the opening and closing of the circuits are effected by the switches JJ′, KK′. Finally, to maintain the same polarity in the two exciters, and in the poles of the alternators, provision is made for coupling and uncoupling them.

The measuring apparatus consists of two lamps, a voltmeter, and an amperemeter; besides which there are several regulating devices. Among these are two rheostats RR (Fig. 16). Each of these belongs to a separate generator, and is used to regulate the current passing from the exciter to the fields. There are also four transformers JJ, KK, by which the currents are reduced to the working pressure (45 volts—25 amperes), as the intensity would otherwise be too high.

The clutch mechanism G (Fig. 13) enables the belt for each alternator to be shifted from the fixed to the loose pulley, or to unite the two fixed pulleys when it is desired to couple the alternators; for, as has been said, the lighthouse may be operated in two different ways, according to the condition of the atmosphere. This apparatus is composed: (1) of a short shaft, upon which are mounted two loose pulleys P′P′, fitted with clutch rods which may be engaged with corresponding holes in the fixed pulleys PP; (2) of two sleeves MM, carrying clutch jaws, which may be engaged by aid of the two levers LL; (3) of the two shifter forks F, by means of which the belts may be shifted from the fixed to the loose pulleys; (4) of a lubricating cup, forming a portion of the bearing.

The regulators for the electric arcs are of the Serrin type, with slight modifications, and enable either of the two systems of lighting to be used merely by changing the carbons. In order to facilitate the control of the light by the attendant, a small prism and lens are attached to the optical apparatus, which projects the image of the carbons upon a screen of ivory. On this screen is a reference line marking the position at which the most incandescent point of the lower carbon should be constantly seen. When the attendant sees that this point is displaced, he raises or lowers the arc by means of a regulating screw acting upon both carbons. A similar lateral adjustment is provided.

In foggy weather a sound signal is used. This consists of a siren placed in the upper gallery and operated by air compressed to two atmospheres. A supply of air compressed to fifteen atmospheres is always maintained in a storage tank, so that the signal may be started at a moment's notice, a reducing valve enabling the working pressure of two atmospheres only to reach the siren. The siren is adjusted to the note mi_3 (326 vibrations per second), as it has been found that a deep note penetrates the fog to a greater distance than one of higher pitch.

The architectural features of the structure (Fig. 10) have received as much attention as the rest of the work. The old lighthouse has been retained as an annex. The new structure, designed by the architect, M. Marbeau, consists of an octagonal tower of granite (Fig. 11). The focal plane of the lamps is 59 metres above the ground and 60 above high water, and its outline may be seen in clear daylight thirty kilometers out to sea.

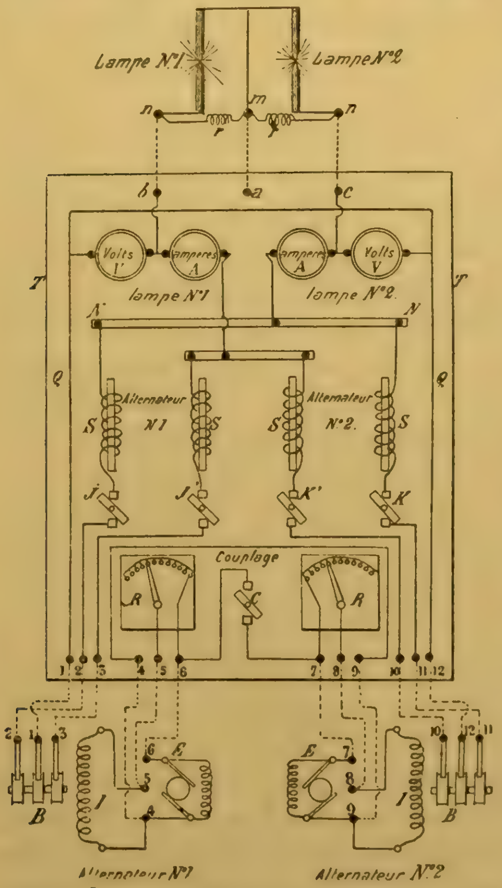


FIG. 16. SCHEME OF THE SWITCHBOARD.

This lighthouse surpasses all others in the world, not only in the range of its light, but also in its equipment. As a matter of comparison we may note that the most powerful English lighthouse is that of St. Catherine, on the Isle of Wight, which has a luminous intensity of 600,000 carcels. The completion of this great structure has been greatly to the honor of M. Bourdelles, director of the lighthouse service, M. Ribiére, chief engineer of the same service, and MM. Blondel and de Joly, the assistant engineers, by whom it was constructed.

It some cases it is desirable to use a lighting system which shall operate for extended periods without the care of a keeper ; the conditions of such a system have been successfully met in connection with the lightning flash system. The first of this kind to be erected in France was at Belle-Isle, in 1890, since which time several others have been put into operation. The most remarkable and the latest device of this kind of light is that of MM. Barbier and Bénard, in which the rotation is effected by means of an electric motor. It is used with excellent results in the lighthouse of Ville-ès-Martin, at the mouth of the Loire, near St. Nazaire. This "permanent" lightning-flash is of the sixth order (0.150 metre focal distance), with two white group flashes, of a duration of one-tenth of a second. The interval in a group of two flashes is two seconds, and that which separates two groups is eight seconds. Fig. 19 shows the case opened, in order that the internal arrangement may be seen. Devices of this sort are being constructed for the lighthouses at the Point de Nalde (Pas de-Calais) and at Isle-de-Bréhat (Côte-du-Nord). Lights of this sort are especially adapted for use on jetties and other positions inaccessible in bad weather, but not of sufficient importance to demand the constant presence of an attendant. With all the precautions which can be taken, however, they render an imperfect protection, but, as they cause a marked reduction in operating expense, they will doubtless continue to be used, not only in France, but elsewhere.

Lightning-flash lights are now being successfully constructed with the Auer, or Welsbach, incandescent gas burner. The first application of this sort was made in 1895 at the Chassiron lighthouse, on the Isle d'Oléron, and the results were so satisfactory to the lighthouse administration that it was decided to apply this system to all lights of the first order hitherto using oil lamps. In 1896 the lighthouses of the Isle de Groix (Morbihan) and of the Isle de Sein (Finistère) were supplied with these lights. The apparatus of the Ar-Men lighthouse (Finistère) has been placed in the hands of the Societé des Etablissements Lepaute, to be converted into an incandescent gas system, and is expected to be in full operation by the close of 1898. This, the

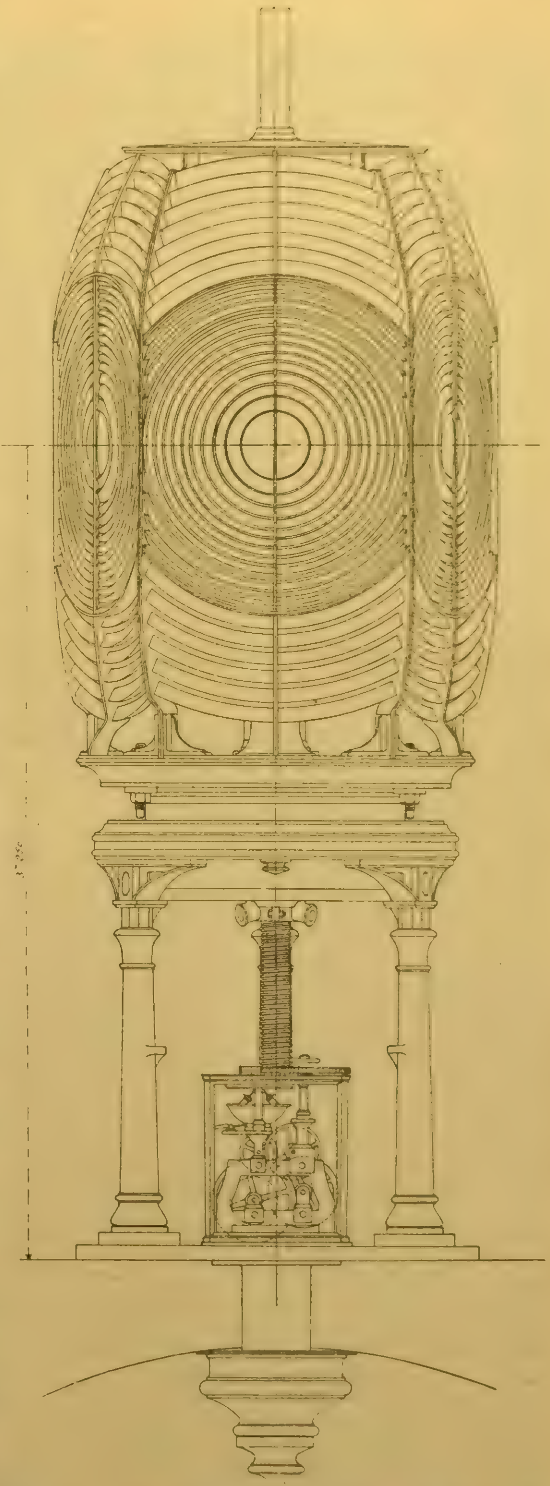


FIG. 17. OPTICAL APPARATUS OF THE AR-MEN LIGHTHOUSE.

latest, type of lighting apparatus (Figs. 17 and 18) consists of three panels with catadioptric above and below, and central dioptric elements, presenting a horizontal opening of 72°. A portion of the light which is emitted in the "dead" angle is utilized by a spherical reflector of pure nickel, of 144° amplitude. The apparatus is so arranged that it may be used either with mineral oil, or with compressed gas burned in incandescent burners. The oil lamp has six wicks, and is provided, like the gas burner, with a mercurial joint, which permits an instantaneous substitution of one burner for the other. The connection to the gas burners consists of a tube formed of the spindle itself, a hole being formed in its centre for a length of 170 metres, terminating in an annular tube filled with mercury. The whole is supported upon a cast-iron plate, to which is attached a vertical shaft provided with a screw-thread at the lower end. This shaft is held above by a bearing attached to the cup, and below by an adjustable socket supported on a cast iron boss carried on the foundation plate. This arrangement has already been employed in the great lighthouse at Fire Island, in the United States. It has the advantage of enabling the vertical shaft to be prolonged, thus insuring a greater degree of stability and reducing the lateral press-

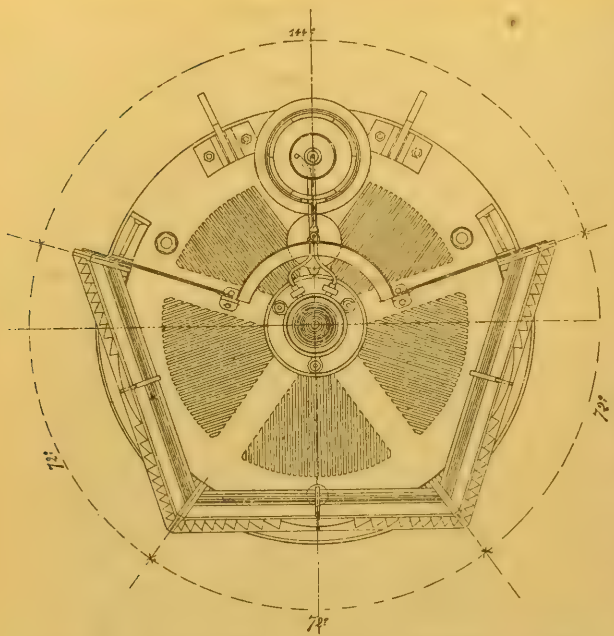


FIG. 18. HORIZONTAL SECTION OF THE AR-MEN APPARATUS.

ure upon the upper bearing. The mercurial float is placed immediately below the working plate, and supports the total weight of the moving parts. Rotation is effected every twenty seconds, producing a group of three flashes followed by a long eclipse. The range of this light in clear weather is sixty miles.*

Some lightships serve to assist in landings (harbor lights), others to indicate isolated dangers, and still others to mark the location of channels. It is evident that those of the first-class demand the greatest degree of perfection, and that great solidity of hull is necessary in those of the first and second classes. In the harbor of New York electrically-lighted buoys are used in preference to lightships, but in France such buoys have been adopted only for the plateau of Minquiers (Manche). The lighthouse department considers these buoys well adapted to indicate isolated dangers, but sailors object to them because they are apt to be concealed in the trough of the waves.

The principal improvements in lightships have been made in those intended for harbor service. The methodical observations which have been made for many years demonstrate that the duration of the waves is almost constant for any given point on the sea, although very different at different points. This fact enables the problem of stability to be solved much more precisely in the case of a lightship than in that of an ordinary vessel. It is therefore possible to meet the required conditions effectively, as has been done since 1890 with the "Nouveau Dyck" ship, anchored near the lighthouse of Gravelines (Nord), and which is furnished with much larger bilge keels, to prevent rolling, than have hitherto been used. In the case of the "Dyck," as well as in that of the "Ruytlingen," of which the general arrangements are shown in Figs. 20 and 21, the experimental data have caused the metacentric radius to be diminished, while the lati-

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* We are indebted to M. Dehesdin, director of the Société des Etablissements Lepaute for permission to describe this apparatus.

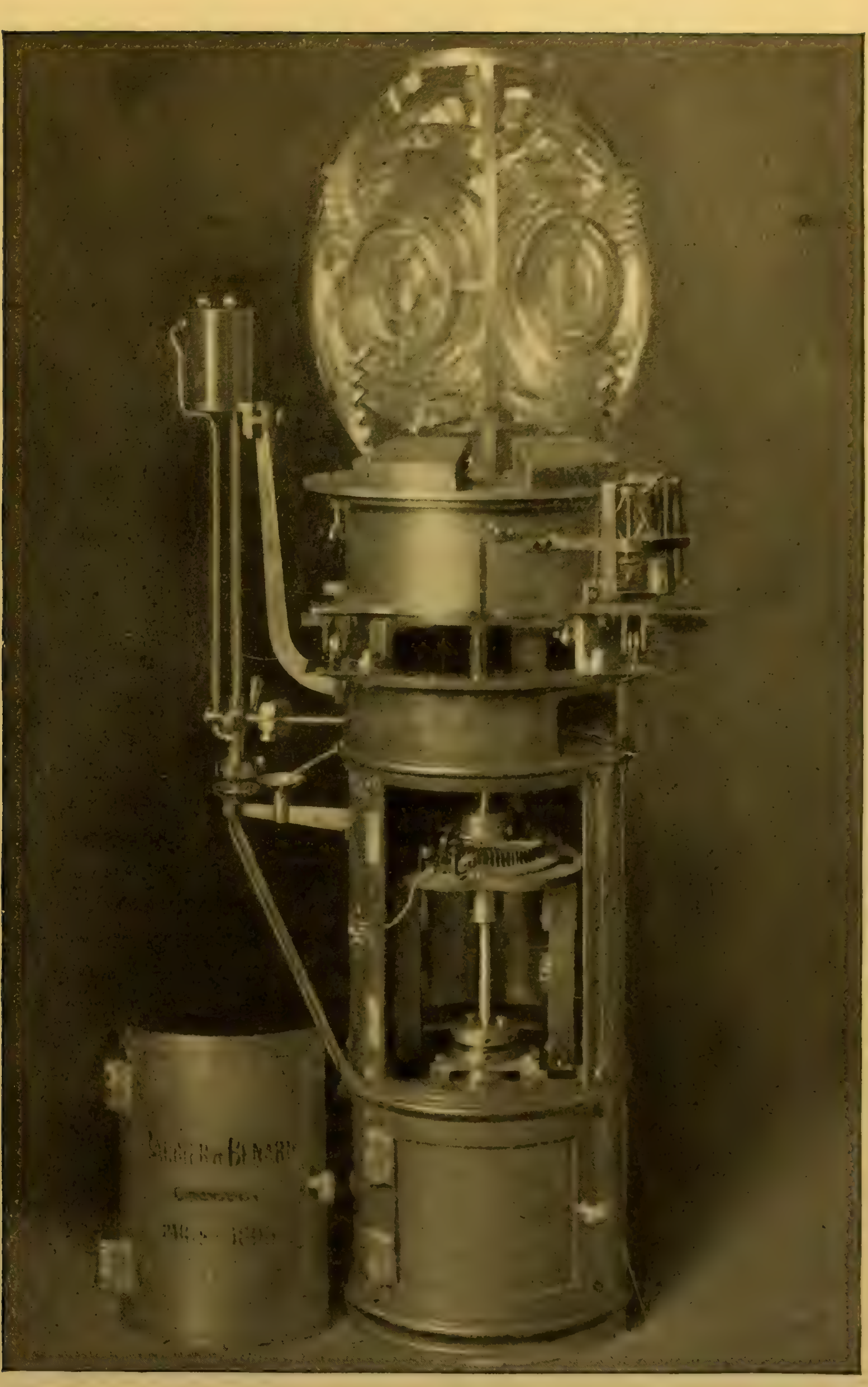

FIG. 19. AUTOMATIC FLASH-LIGHT MECHANISM.
As constructed for the Ville-és-Martin lighthouse.

tudinal and longitudinal moments of inertia have been augmented by a new arrangement of the ballast.

The "Ruytlingen," the principal lightship in the French service, has a length of 30 metres, a deck width of 7.82 metres, and a width at the waterline of 7.56 meters, with a displacement of 338 tons. The deck is entirely of steel, and the hull is sheathed with galvanized sheet steel. This vessel was placed in the Dunkerque channel in January, 1891, being held by a mushroom anchor 2,000 kilogrammes in weight, secured by a chain made of iron 40 millimetres in diameter. The iron was required to show, under test, a resistance of 38 kilogrammes per square millimetre of section (54,000 pounds per square inch) with an elongation of 24 per cent.; such strength being deemed sufficient to withstand the heaviest seas.

The lighting apparatus of the "Ruytlingen" (Fig. 20) consists of nine reflectors 0.500 metres in diameter, provided with double-wick lamps, grouped, three by three, in a vertical plane. This gives three sets of luminous rays, each equal to 1,200 carcels. A complete rotation is effected in one minute, the flashes being separated by intervals of twenty seconds. The lamps are maintained at a constant level by means of a Cardan suspension, or universal joint, connected with an internally-toothed ring, into which is geared a pinion carried by a shaft parallel to the mast. The driving machinery rotates the vertical shaft, which imparts the motion to the internal gear wheel and thus revolves the supporting rings in which the lantern is carried. The lantern itself is 2.45 metres in diameter and 3.25 metres in total height, and is attached to the mast by a cylindrical sleeve of sheet-iron. In foggy weather a compressed-air siren produces a group of two tones of the same pitch, alternating with one tone of a different

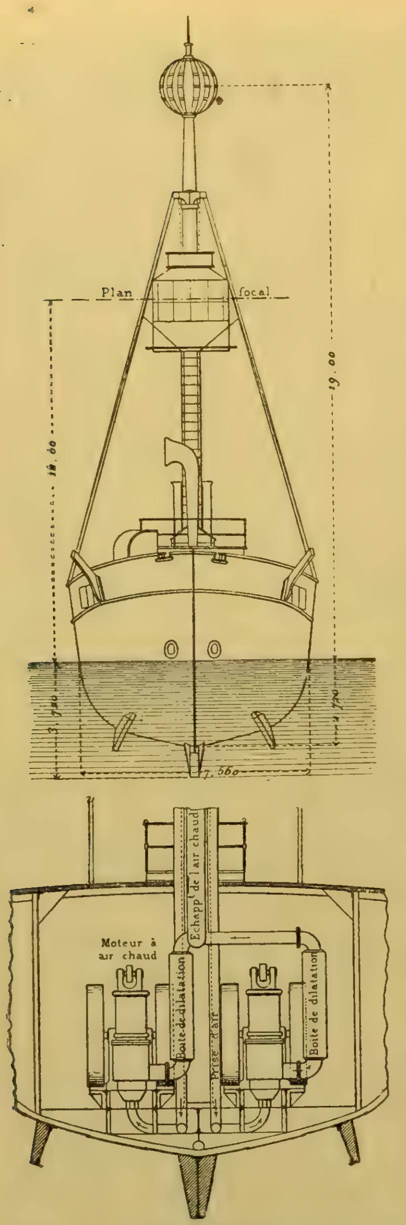

FIG. 20. TRANSVERSE ELEVATION AND SECTION OF THE RUYTLINGEN LIGHTSHIP.

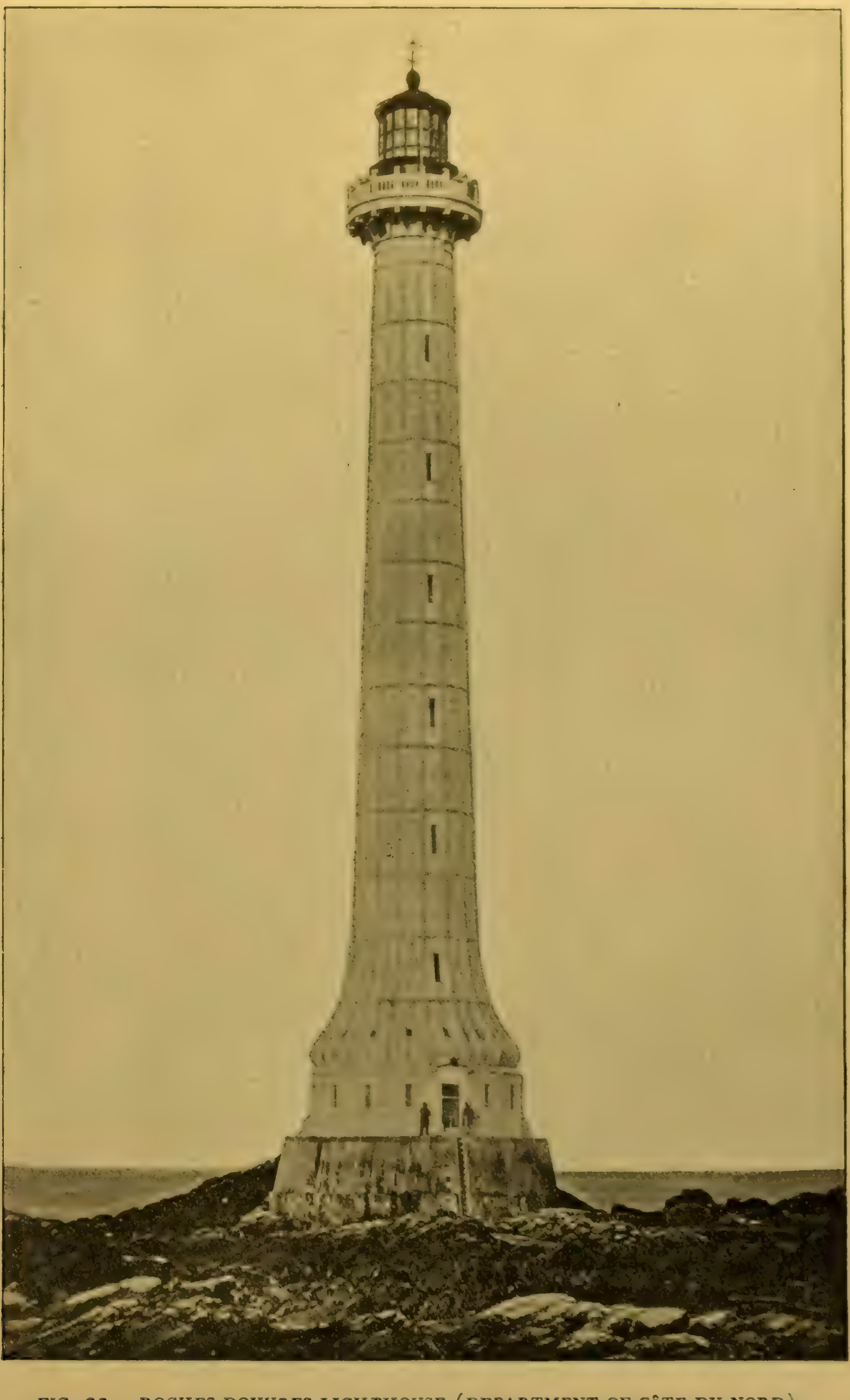

FIG. 22. ROCHES-DOUVRES LIGHTHOUSE (DEPARTMENT OF CÔTE-DU-NORD).

pitch every thirty seconds. The siren mechanism includes two Bénier hot-air engines (Fig. 20) of 9 h. p., operating two high- and low-pressure air compressors, which may be driven by a direct connection with the motors. A steam pump is used to keep in circulation the cooling water drawn from the sea for each air motor. As about half an hour is required to start the air motors, and as it is sometimes necessary to start the siren promptly upon the appearance of fog, two sheet-iron reservoirs of about three cubic metres' capacity are provided, which are always kept charged with air under a pressure of fifteen atmospheres. A reducing valve enables this storage capacity to be drawn at a constant pressure of three atmospheres, the normal working pressure of the siren. The latter is mounted on a vertical axis, and its velocity of rotation is controlled by a centrifugal brake. The first cost of the "Ruytlingen" was 300,000 francs, and the annual expense of its maintenance reaches 40,000 francs.

Since 1897 the lighthouse department has been experimenting with a new device invented by the able engineer-in-chief, M. Ribère, which has for its object the use of flash-lights operating with Welsbach burners supplied with compressed oil gas. These experiments have been tried on the lightship of the Grand-Banc (Gironde). During 1898, after the tests have been completed, it is expected that, if the results are satisfactory, this system will be applied to the lights at Rochebonne, 33 miles to the west of the Isle de Ré, de By, de Mapon, and de Falais (Gironde).

The great buoy at Dunkerque (Fig. 24), which is the most pow-

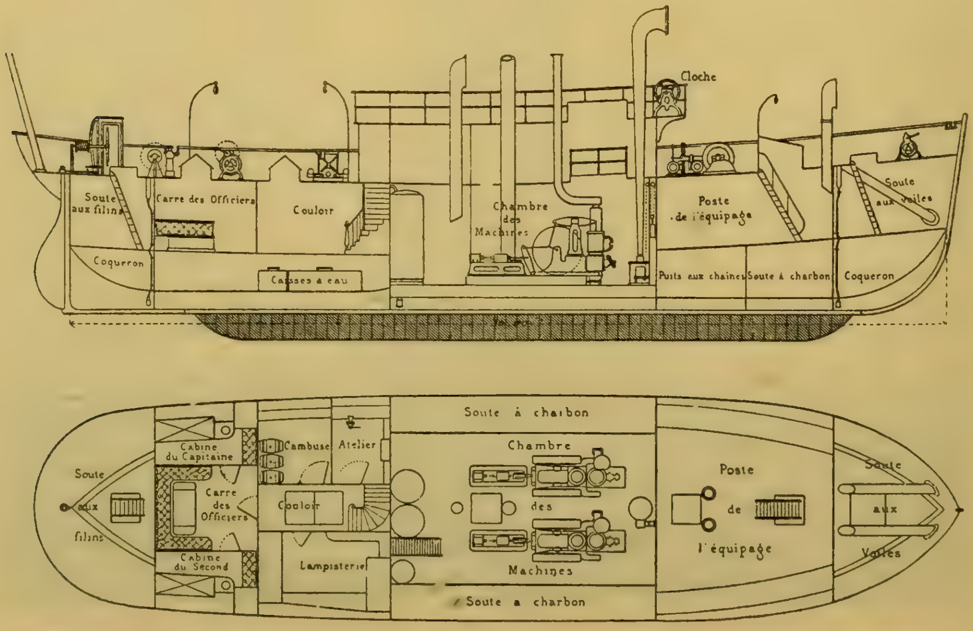

FIG. 21. LONGITUDINAL SECTION AND PLAN OF THE RUYTLINGEN LIGHTSHIP.

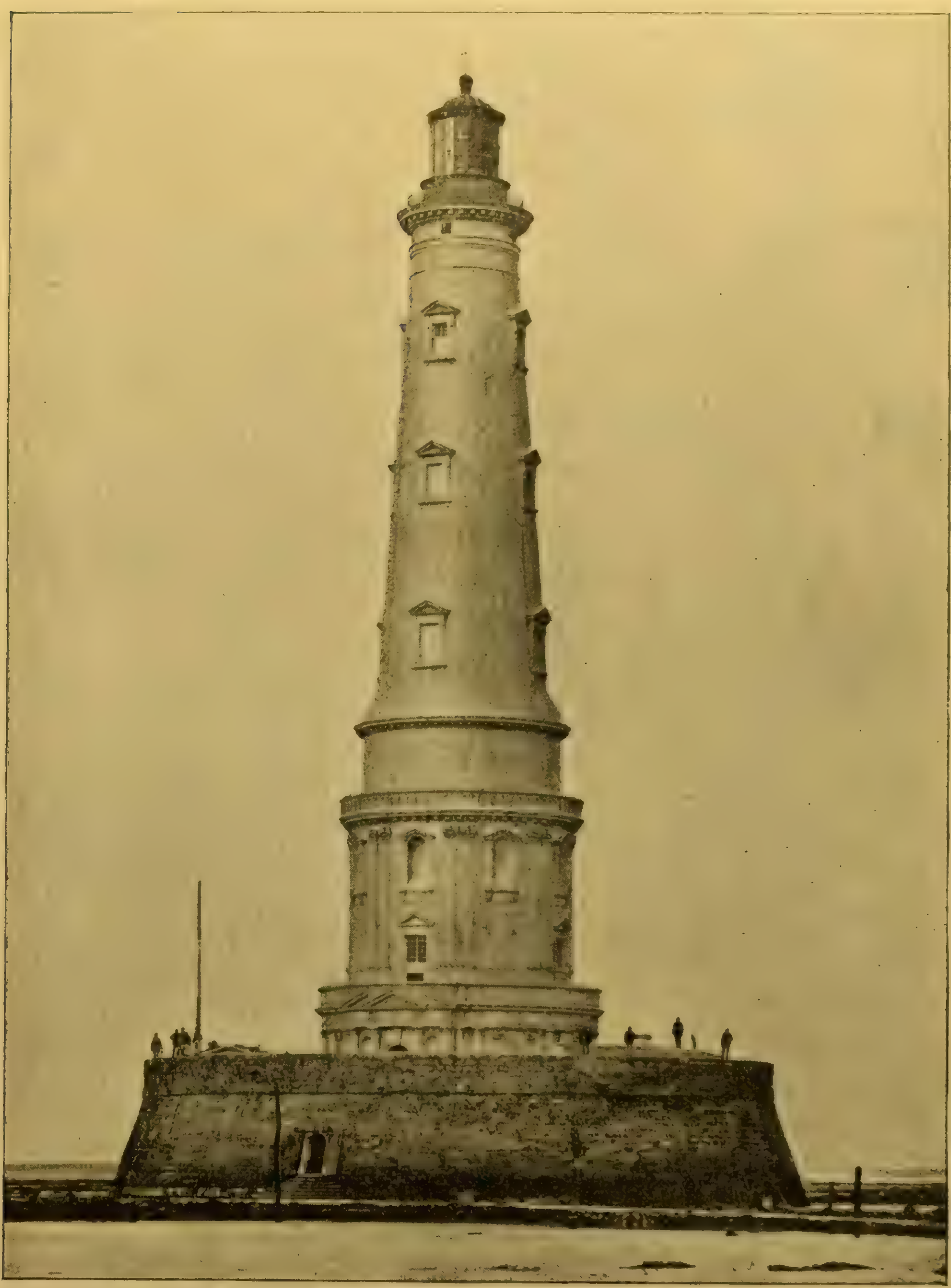

FIG. 23. CORDOUAN LIGHTHOUSE (DEPARTMENT OF GIRONDE).

erful yet constructed, carries an optical system 0.375 metres in diameter, carried on a Cardan, or universal suspension, as is the case with all the French buoys. The light is a fixed one, and only a dioptric lens system is employed. The lantern is made of as small dimensions as possible, and contains a double-tube gas burner, which

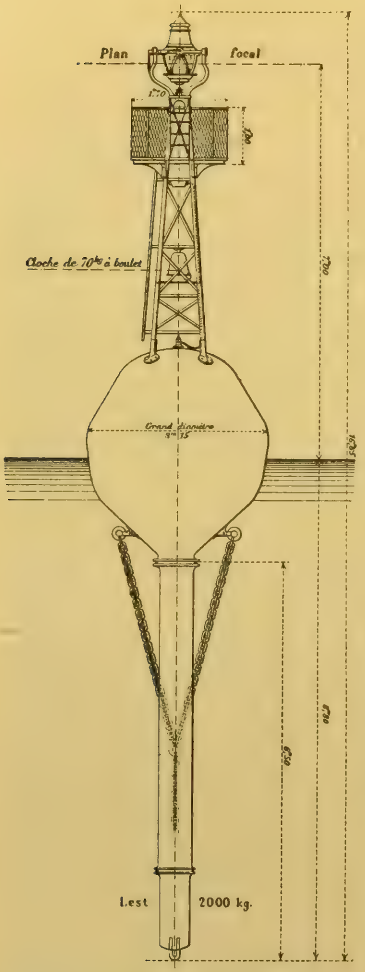

FIG. 24. LUMINOUS BUOY AS USED IN THE HARBOR OF DUNKERQUE.

consumes 120 litres of compressed oil-gas per hour. Especial care has been taken to provide for a proper circulation of air and removal of the products of combustion, in order to secure proper draft and to prevent extinction of the light, as well as to avoid accidents.

The buoy has a capacity of 18 cubic metres and a tail 6.50 metres in length, carrying 2,000 kilogrammes of ballast, the total draft being 9 metres of water. The luminous power is equal to about forty carcels, and the focal plane is about 7 metres above the surface of the water.

The total number of lights of all sorts in service on the coasts of France and Algiers, including fixed, occulted, and flash lights, is 640, among which are 8 lightships and 81 luminous buoys. Along the coast of Tunis there are 37 fixed lights using oil lamps, 10 permanent lights using gas, and 6 oil flash lights.

The principal lighthouses of France, other than those already mentioned, are those of Cordouan and of Roches-Douvres (Côte-du-Nord). At present the total luminous power exceeds 10,000,000 carcels for France and Algeria, and 8,000 for Tunis, of which only 7,150,747 carcels were in service on January 1, 1895. These figures speak for themselves, and bear stronger testimony to the work of the French central service of lighthouses than any words of eulogy, showing, as they do, how completely the engineers,* MM. Bourdolles, Ribière, and de Joly, have maintained the scientific traditions of their predecessors, the Chevalier Borda, and the physicist, Fresnel.

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*The author desires to acknowledge the facilities which these gentlemen have placed at his disposal in the preparation of this article.

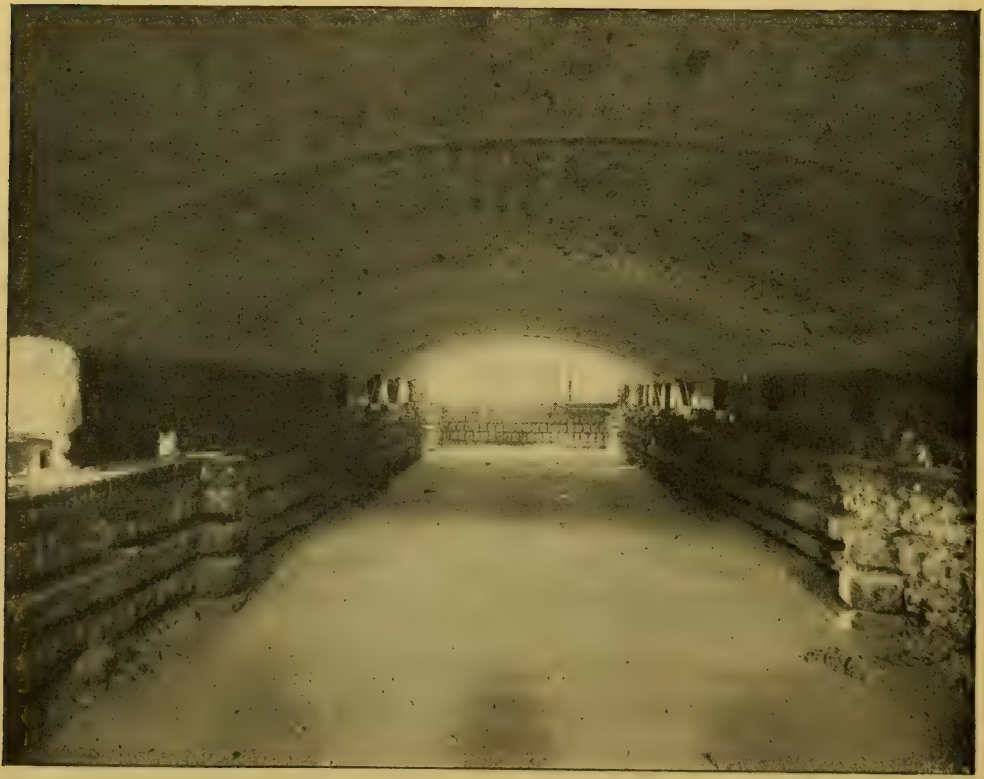
CONTINUOUS OPERATION IN THE MANUFACTURE OF WINDOW GLASS.

By Robert Linton.

THE most important event in the history of the window glass industry is the introduction of the continuous melting tank furnace, which is now coming into very general use in place of the older pot furnace. For the sake of clearness, let us at the outstart briefly define the two styles of furnace. A pot furnace is a furnace of rectangular plan, containing two rows of large crucibles, in which the glass is made. There are usually eight or ten pots in a furnace. The batch—the mixture of sand, limestone, and alkali—is filled into the pots, decomposed, and melted down into glass, the filling being repeated until the pots are full. Then the glass is cleared, settled, and worked out. The furnace is turning out glass only about a third of the time. A tank furnace consists essentially of an oblong hearth, the "tank," containing a bath of liquid glass heated by overhead firing. Upon this bath of glass the batch is filled at one end and floats slowly down, melting into glass as it goes, and is worked out continuously at the other end. A tank furnace might be called an open-hearth glass furnace. Near the working end of the tank are placed floating bridges of fire-clay, reaching down about a fourth of the distance to the bottom. The glass must pass beneath these before it reaches the working end, and is thus cleared of light impurities floating on the surface and thoroughly mixed. To avoid confusion, we will note that the term "tank," although often applied to the whole furnace, properly applies only to the hearth containing the bath of glass; for the whole furnace the term "tank furnace" should be used.

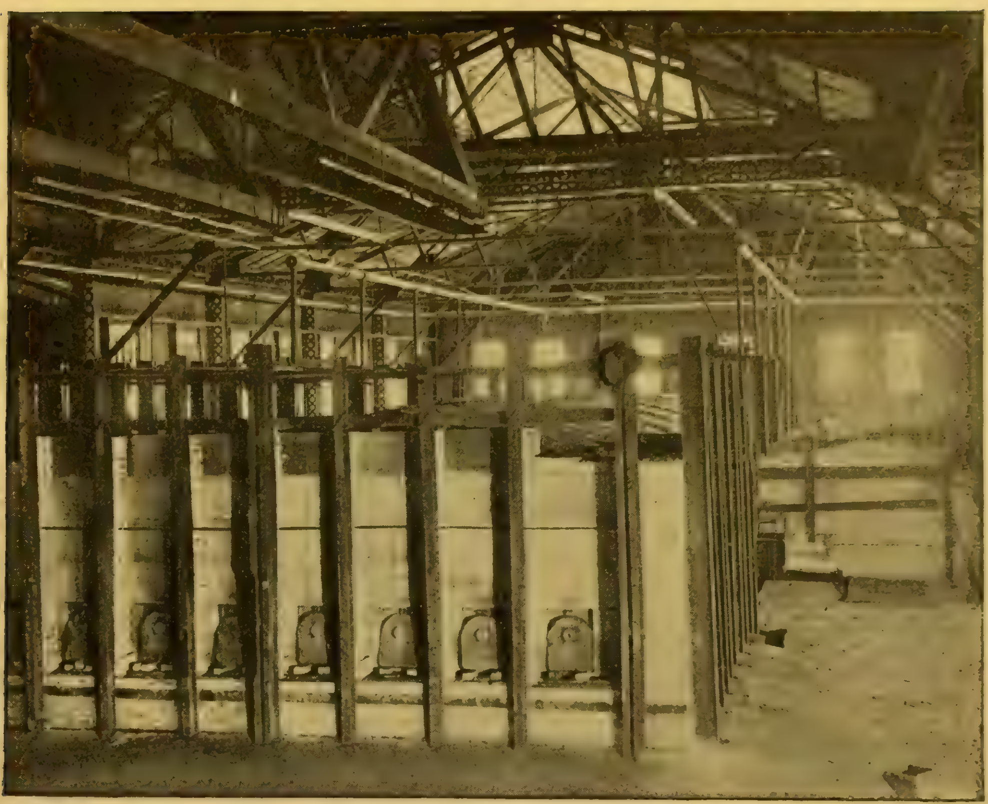
The first tank furnace was built about 1860 by Messrs. Casimir Lambert & Florinflot, window-glass manufacturers, of Charleroi, Belgium. It was very crude in design, and fired directly with coal, after the manner of the pot furnaces of that time. In a pot furnace, however, the pot itself becomes heated, and helps the melting along; as much heat plays around the pots as over them. The outside of a tank, on the other hand, must be kept cool, heat being developed by firing from above. Sufficient heat cannot be developed by means of direct firing, to say nothing about the dirt carried in from the grates. The interest attaching to this first tank furnace is only historic. It failed of any practical success.

It was only through the development and application to metallurgical operations of gas-firing that the tank furnace could come into use at all. This is but one instance of the far-reaching influence of gas firing upon glass manufacture. It has entered all departments where heat is required, effecting great improvements. The direct coal-fired plants of twenty years ago cannot compete, either in quality of product or economy of operation, with the gas fired plants of the present time. Producer gas is the kind of gas ordinarily used for firing glass furnaces,—a comparatively weak gas, the lowest, in fact, of all fuel gases in thermal value. Made by passing a jet of steam and air through a bed of coals, the result is a mixture of hydrogen, carbonic oxide, and the volatile hydrocarbons of the coal as combustible and heat-producing constituents, and carbonic acid and nitrogen as non-combustible constituents, serving merely to dilute the gas. A good producer gas will contain but thirty or forty per cent., by volume, of combustible elements. It burns feebly in the air, and requires to be burned hot, and fed with hot air when used as fuel. The problem of



THE INTERIOR OF A TANK FURNACE, NEARLY EMPTY.

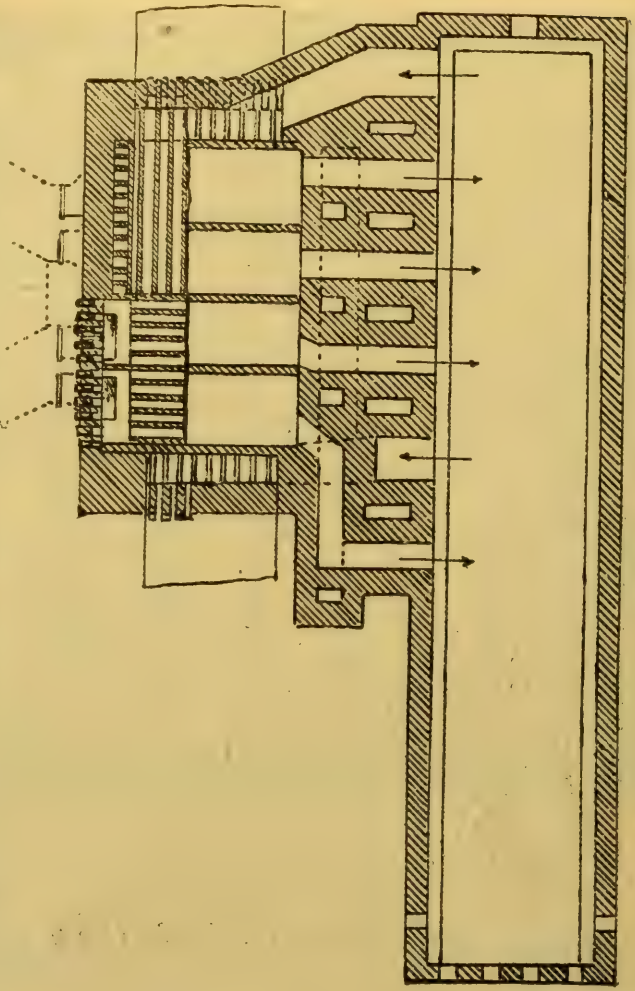
Taken at the end of a year's run. The blocks, which were made from American clay, had been in place from two to seven years, except the top course, which had been in for seven months.

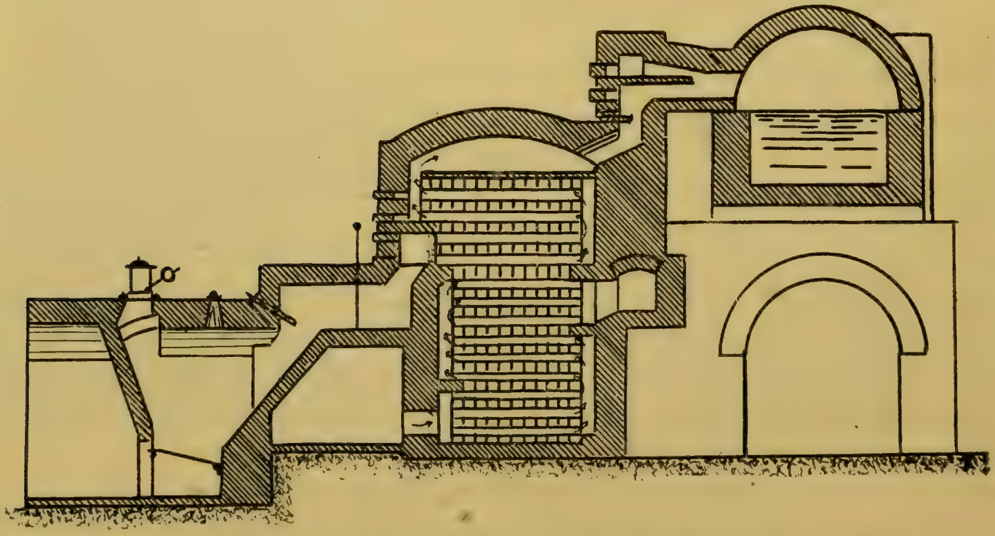


SQUARE-FRONT TANK FURNACE IN AN AMERICAN PLANT.

its successful use is, therefore, chiefly one of proper preheating, utilizing for this the waste heat of the spent products of combustion after they leave the furnace.

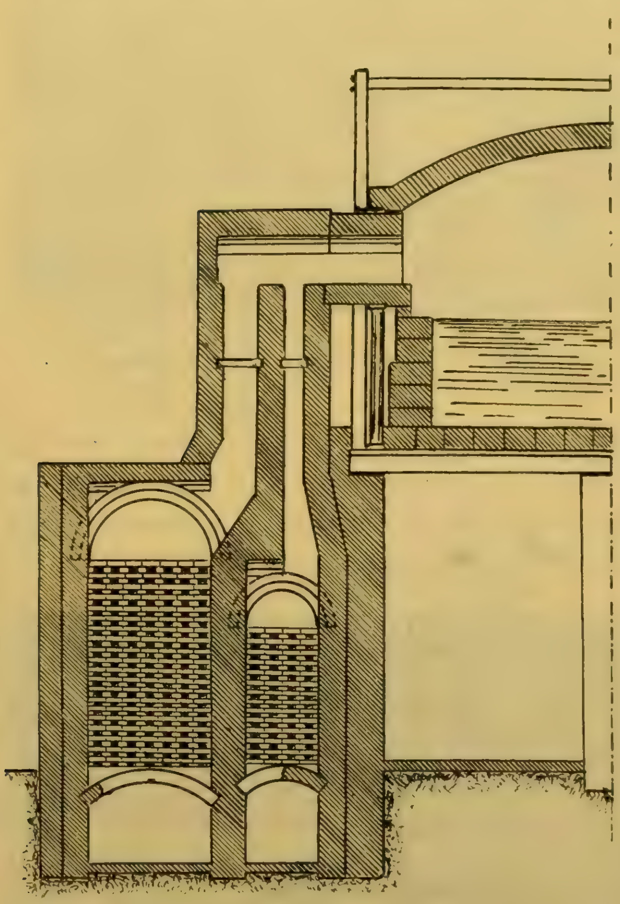
This method of preheating may follow either the regenerative or the recuperative system. A regenerative furnace has two pairs of chambers—the regenerators—filled with loosely-laid fire-brick. The air and gas enter the furnace through one pair, and the products of combustion pass to the stack through the other. The direction of the flame is reversed periodically, so that each pair of regenerators is in turn heated by the outgoing waste gases, and imparting its stored heat to the ingoing elements of combustion. In the recuperative system there is no reversal of the direction of the flame. The recuperator consists of two sets of tortuous flues, separated by thin partitions. The outgoing gases pass through one set, and the incoming air through the other. The heat of the former is imparted to the latter through the thin flue walls. The gas is usually not preheated, but the gas producers are set close to the furnace, so that the initial heat of the gas in the producers is not lost between the producers and the furnace. The recuperative system has been applied with some success to bottle tank furnaces, notably by Dralle in Germany and Radot and Charneau, in France, but for window-glass tanks it has not proven very satisfactory. The successful development of the tank furnace for window glass has been solely in following the regenerative system. It is not surprising, then, to find that the first successful attempt in applying the tank idea was made by Frederick Siemens, the celebrated German metallurgist, associated with C. W. Siemens, of Westminster, England. He exhibited a plan of regenerative tank fur-





PLAN AND CROSS SECTION OF CHARNEAU RECUPERATIVE TANK FURNACE.

nace at the Vienna Exposition of 1873, and from that time devoted considerable attention to its development. His experiments and his success were mainly in the manufacture of bottles. This may be due to the fact that in Europe bottle glass is, as a rule, more fusible than window glass, inferior and more fusible materials entering into its composition for the sake of economy; and it was therefore better adapted for experiments with a new-style furnace. The Siemens Company at Dresden has been very successful in the development of the bottle tank furnace and in the manufacture of bottles. At its immense plant it has a number of furnaces in operation, entirely circular in shape,—a style that deserves the attention of other bottle manufacturers.

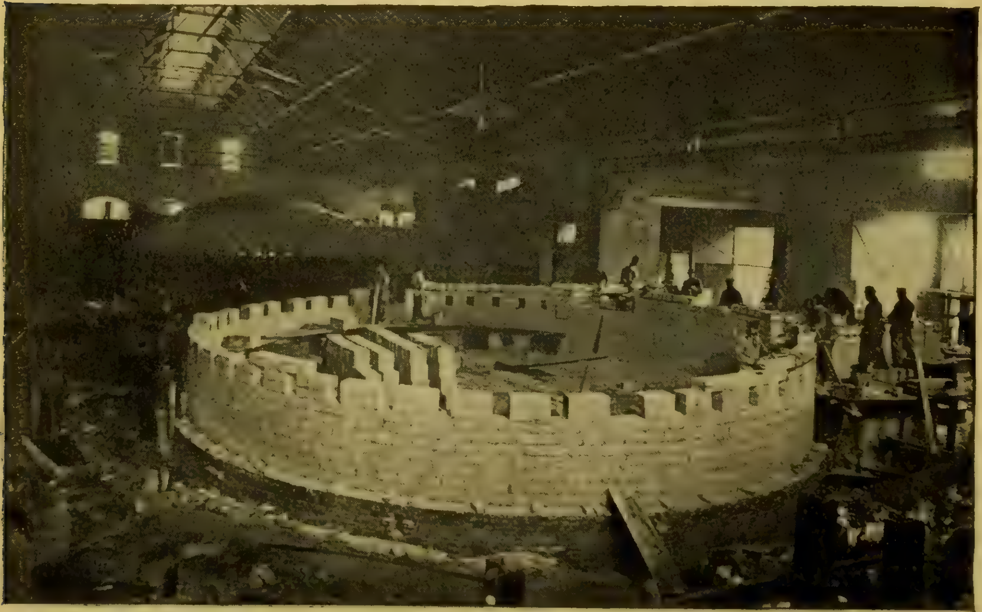


CROSS SECTION OF PORT, NECK, AND REGENERATOR OF BAUDOUX-PAGNOUL TANK FURNACE.

The first manufacturers of window glass to use the tank furnace successfully were Pilkington Bros., of St. Helens, England. They discovered and corrected many defects in the original Siemens construction, and developed a very efficient furnace, though of small size. About the same time the Belgian and French manufacturers began to take up the matter. The history of the development of tank construction on the continent naturally associates itself with the names of Eugene Baudoux, in Belgium, and Emile Gobbe, in France and later in Belgium. In 1884 M. Baudoux built a furnace with a capacity of thirty-six blowers, and, immediately afterwards, another of forty-five blowers' capacity. This was a radical departure from the small tank furnaces that had been operated previously. By increasing the size the economy of operation was much increased. Indeed, so efficient were his

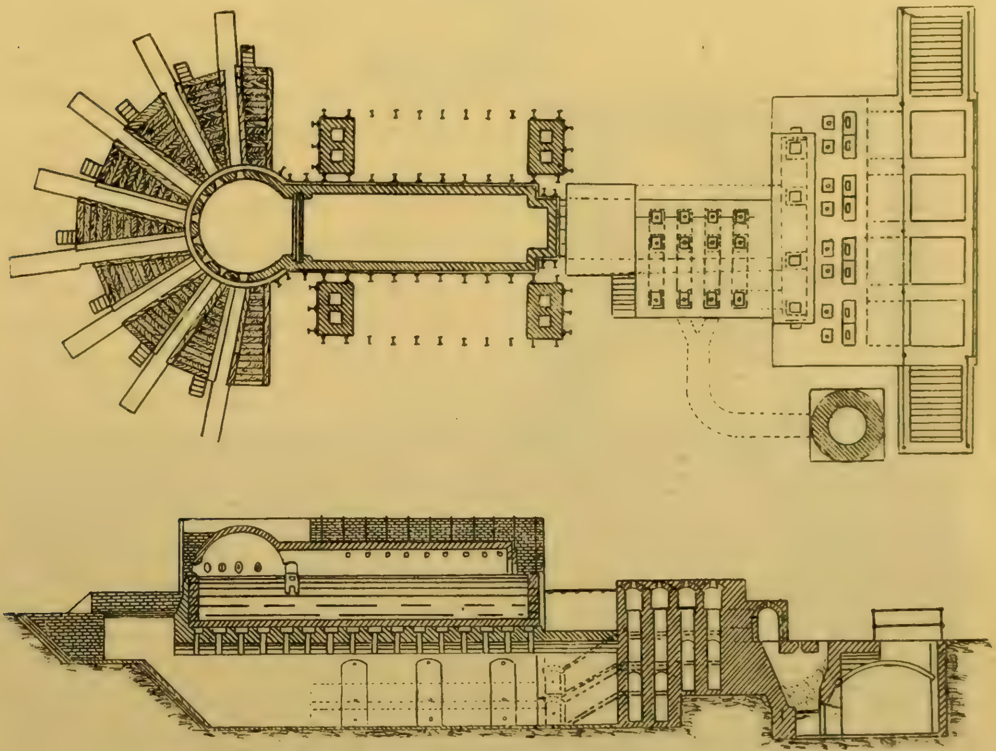
CIRCULAR REGENERATIVE TANK FURNACE FOR GLASS-BOTTLE MANUFACTURE.
SIEMENS CO., DRESDEN.

furnaces that they excited bitter opposition on the part of the workmen, on account of their saving of labor and fuel, and in the general strike of 1886 a mob destroyed his factories. It is said that, had M. Baudoux fallen into the hands of the mob, his fate would have

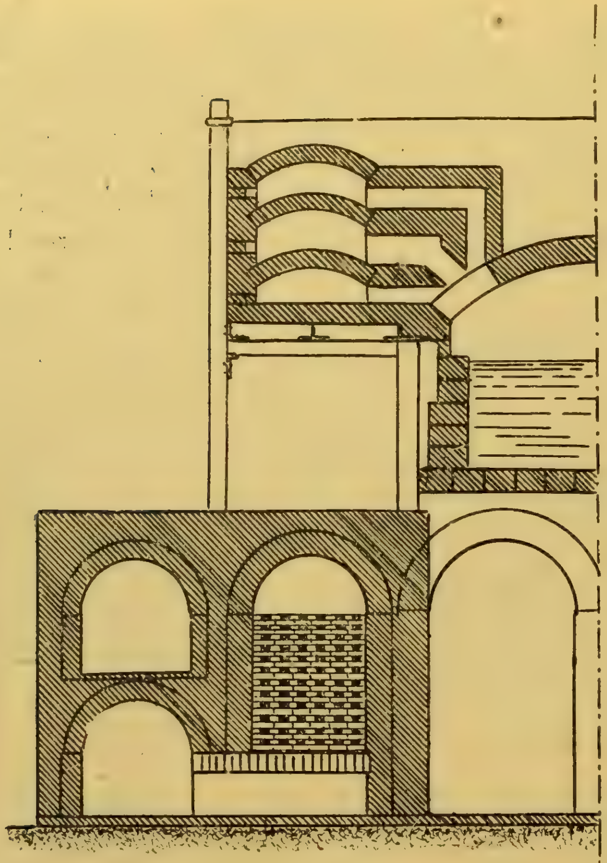


CIRCULAR REGENERATIVE TANK FURNACE UNDER CONSTRUCTION.

been that decreed by a certain Babylonish king against all who would not fall down and worship him. It is characteristic of the tremendous energy and determination of M. Baudoux that he began, without delay, erecting new works even superior to the old ones. His plant has been in successful operation ever since. No one is entitled to more credit in the development of the tank furnace than he. He has made many and expensive experiments, and has not kept the results secret, but has allowed others to benefit by them. The very destruction of his factories served more perhaps than anything else could to bring the tank furnace to the notice of glass manufacturers. It is worthy of note that his most recent experiments have been with a tank furnace of extremely small size,—just the other extreme from his early experiments,—hoping to determine the limits of size in this direction and the relative efficiency and economy of large and small tanks. The Baudoux tanks follow partially the original Siemens lines, but there are many improvements in the details. The style of construction is familiar in the United States under the name of the Pagnoul tank furnace. M. Pagnoul was associated with M. Baudoux in the construction of his furnaces, and afterwards joined M. Gobbe in forming the firm of Gobbe & Pagnoul. M. Gobbe has devoted more time to


PLAN AND LONGITUDINAL SECTION OF 24-BLOWER GOBBE TANK FURNACE.

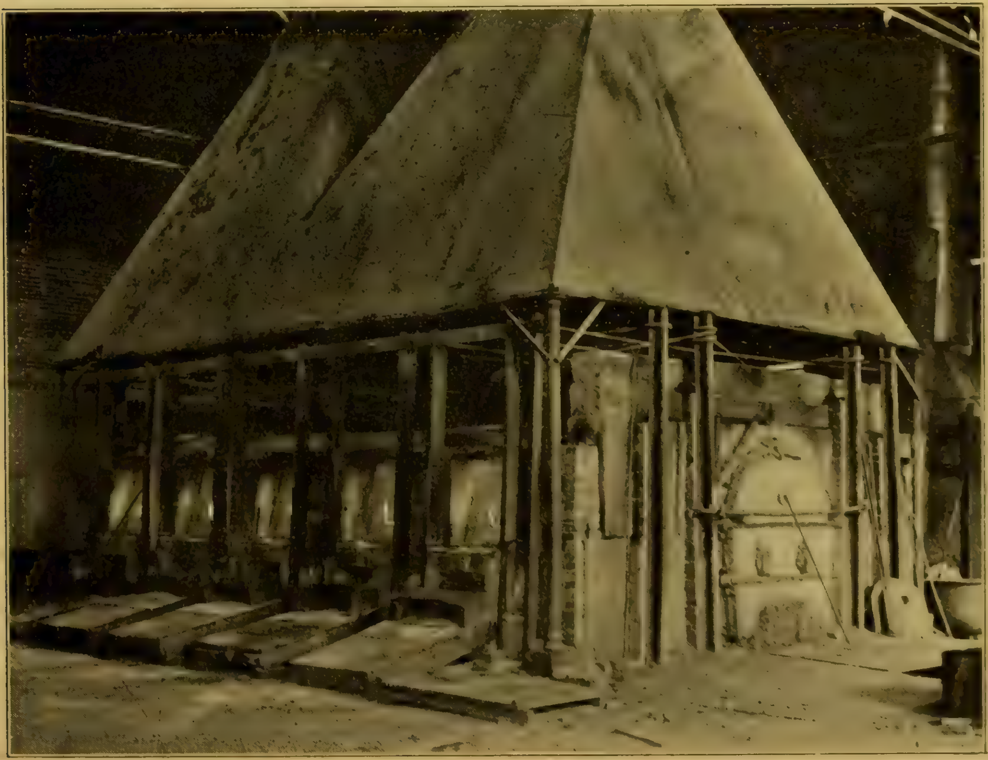
small-size furnaces, and has developed a construction which, for a capacity up to about thirty-six blowers, is unsurpassed by any yet designed. As the tendency in the United States has been to build extremely large furnaces, Gobbe & Pagnoul have used the Baudoux-Pagnoul construction in the furnaces they have built there.



CROSS SECTION OF PORT AND REGENERATOR, GOBBE TANK FURNACE.

More than thirty window-glass tank furnaces had been built in Europe before one was built in the United States. Conservative American manufacturers hesitated to assume the large initial expenditure for tank plants, which, while they might bring about some economy of operation, might also produce glass of inferior quality. The experiments in Europe were watched, as far as was possible from a distance, with much interest. It is less than ten years since the matter was taken up seriously by a few American manufacturers who were convinced that the success claimed for the tank furnace was a reality. An especial encouragement was afforded in the discovery in the United States of natural gas in abundant quantities for manufacturing purposes. Natural gas is the fuel *par excellence* for glass-melting, and especially for the tank furnace. The whole of it is highly combustible. It is clean, powerful, and easily controlled. For a time the supply continued to be abundant, but it is nearing exhaustion now, and many plants have been obliged to alter their furnaces for the use of producer gas, which, when properly controlled, will make just as good glass as natural gas, although it is not nearly as convenient. Though aided by the convenience of their fuel, those American manufacturers who took the initiative had, to a certain extent, to go through the same experimental difficulties that the European manufacturers met. Their experience was not always successful; still it was satisfactory enough to demonstrate that a tank furnace, properly constructed and properly controlled, will produce as fine a quality of glass as was ever made in a pot furnace, and at considerable economy of fuel and labor. The tank furnace soon began to come more rapidly into favor, and at present more than a score are in operation in the United States, producing more than sixty per cent. of all the glass manufactured in the country, including the best and most popular brands. Each year sees the firing up of new ones, and the abandoning of old pot plants. The experience already gained by manufacturers renders it possible now to designate pretty accurately the general lines on which a tank furnace should be built to give a good product and economical operation, so that the building of a tank furnace need not now be considered an experimental investment.

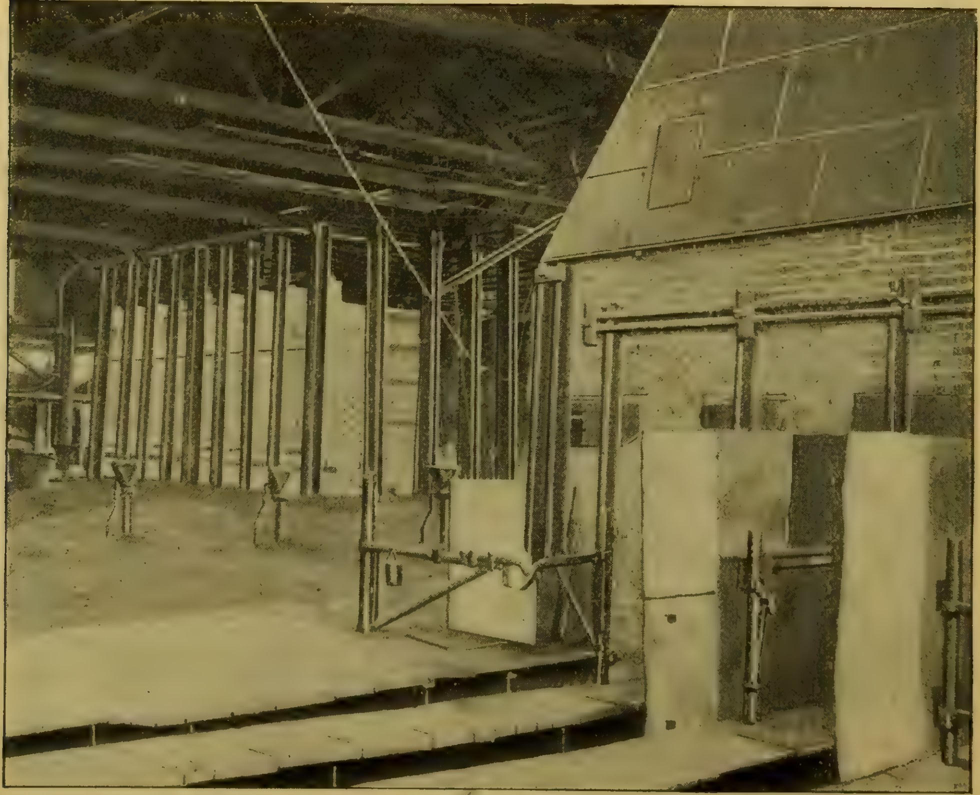
After all, the work that a tank furnace has to do does not differ from that of a pot furnace. One is in continuous operation, the other intermittent. That is all. The metallurgical operations and chemical reactions are precisely the same in the one case as in the other, and must be provided for alike. It takes a certain time to make a melt in a pot furnace, and, if an attempt be made to hurry it, the glass will be spoiled. Likewise it takes a certain time to melt glass in a tank furnace, and this is regulated by the length of the furnace



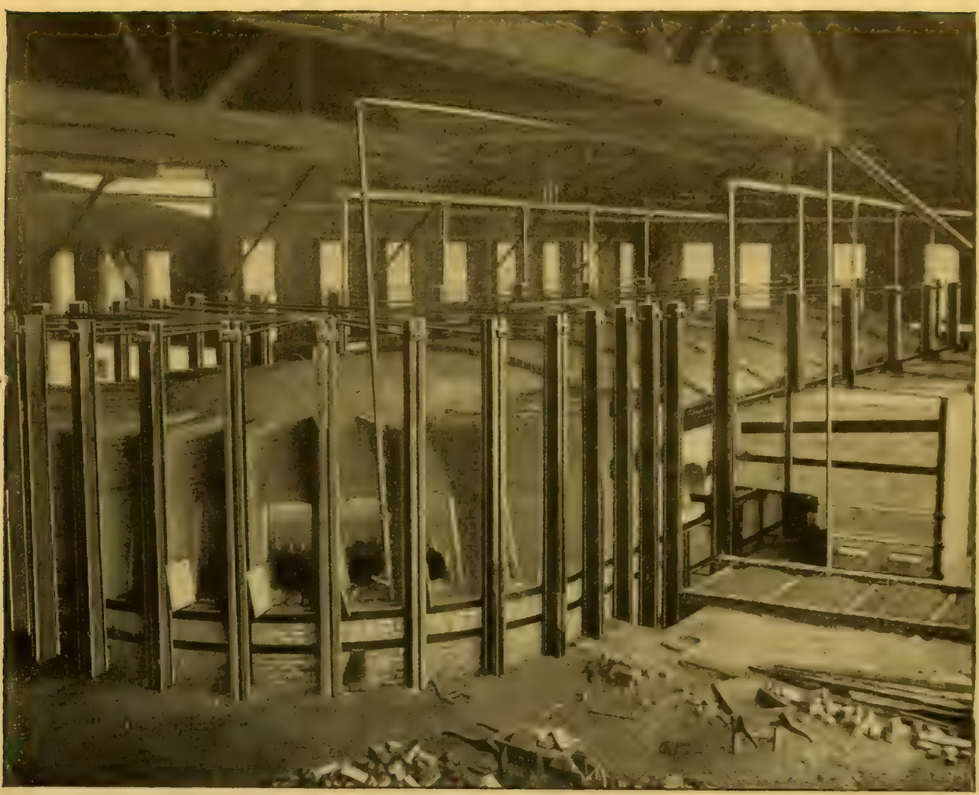
A REGENERATIVE POT FURNACE.

and the rapidity of the current of the batch. If a furnace be run beyond its capacity, the melting batch is pulled down before it has had time to be made into good glass. To make good glass regularly the tank furnace must be kept within its capacity.

The first tank furnaces that were built were designed according to the idea that, since all the heat is applied from above, the melting and fining take place entirely on the surface. The capacity of the tank, therefore, was made proportional to its superficial area, and depth was neglected as a factor. Siemens soon observed that this position was not altogether correct, and that it was necessary to have a layer of glass to melt on, not only to preserve the bottom of the tank, but also to attain good results in melting. He took the view that glass fines as it sinks beneath the surface, and that the depth of the tank is necessarily considerable if the glass is to be well fined. He took out a patent in 1879 on tanks more than eighteen inches deep. Fining, however, has nothing to do with either depth or direction, but merely with heat. The deep tank does not facilitate fining any more than melting, but aids both in storing heat and giving it back to the batch from below; it helps also to preserve an even



TANK AND BLOW FURNACES IN A PENNSYLVANIA GLASS WORKS.



A ROUND-FRONT TANK FURNACE.

melting environment for it. M. Emile Gobbe went much further in elaborating the idea experimentally and theoretically. He ascertained that the calorific rays traversing the bath of glass undergo a diminution in intensity amounting to $\frac{5}{1000}$ per centimeter, and reasoned that, by increasing the depth of the tank to a point where the glass becomes solid or practically so on the bottom (about two meters), all the thermal rays will be absorbed and given back to the furnace to assist in the melting. He also concluded that tanks of the same superficial area and different depths have productive capacities proportional to their depths, and that the capacity of a tank is, therefore, proportional, not to its superficial area, but to its cubical contents, laying down the rule that not more than eight to ten per cent. of the total charge of the tank should be worked out in twenty-four hours. Actual practice has not often reached as high an efficiency as this, and has shown that it is best to take into account both superficial area and cubical contents in determining the capacity of a tank. They are equally important factors, varying somewhat with the style of tank furnace built. The average of a number of European factories where a high efficiency is generally attained gives a superficial area of twenty-six square feet per blower, and a daily output of seven and one-half per cent. of the total charge of the tank. Mr. Gobbe's small tanks have been very successful in Europe. In addition to a well-proportioned tank, he has also designed carefully his firing, which is, after all, the vital part of a glass-melting furnace,—the part that does the work. The construction and disposition of ports, necks, regenerators, flues, valves, and stack must be such as to shoot down upon the batch a sheet of clear, hot, keen flame. A temperature of about 2,600° F. is required. In the Gobbe tank furnace a number of small ports enter through the crown. The sheet of flame is nearly continuous, and has a good pitch to the furnace.

In the United States there is much dissimilarity in style of construction. The experiences of different manufacturers have not led to identical conclusions. All are aiming at greatest efficiency, but all do not follow the same ideas in modelling their furnaces to secure it. Notwithstanding these differences in structural details, the furnaces are generally very efficient, and are producing window glass inferior to none made anywhere in the world. An accurate comparison of the efficiency of the American and European plants would be very difficult to make, as conditions of labor and market especially, and other conditions in less degree, differ widely. There is a uniform efficiency in the European plants, a studied and systematic economy, an intelligent adaptation of their plants to the requirements of their situation. One point is worthy of note. In Belgium all the glass is blown over the tank, the surplus heat of the furnace being used for the necessary reheating of the glass in blowing. In the United States separate furnaces—the blow furnaces—are kept up for this, entailing considerable expense for operation and maintenance. In point of size the United States have gone much beyond the European construction. M. Baudoux's forty-five-blower tank is still one of the largest, if not the largest, in Europe. This is an ordinary capacity in the United States, and there are furnaces now in operation of sixty blowers' capacity. Such a furnace represents in itself a capacity larger than that of any entire plant in operation previous to the introduction of the tank furnace.

The efficiency of the regenerative tank furnace, expressed in terms of the percentage of the total heat potentiality of the fuel used and actually absorbed in the glass melting, shows a large gain over the pot furnace. For window-glass furnaces the latter style shows an efficiency of four or five per cent.; the tank furnace, on the other hand, ten or twelve per cent., based on the use of a good producer gas made from bituminous coal. A still greater efficiency may be expected to result from further experience and improvements.

EVOLUTION IN CENTRAL-STATION PRACTICE.

By Charles F. Scott.

THE principal functions of an electric power system are the transmission of energy from a power station to the place where the power is to be supplied—the subdivision into small units of power generated in large quantity, and the utilization of the power through motors, lamps, or other devices.

The first of these, the function of electricity as a carrier or conveyor of power, is the one which has most to do in determining the electrical characteristics of the system.

The controlling element in electrical transmission is pressure, or electro-motive force. The flow of electricity, like the flow of water, requires a much smaller conductor for delivering a given amount of energy if the pressure be high and the current small. Again, both with electricity and water, the greater the distance, the larger must be the conductor, if the same power is to be transmitted with the same loss. To transmit over a great distance, therefore, it is necessary that the pressure be high in order that the dimensions of the conductor may be small and its cost low, and, for given conditions of loss and cost, the greater the distance, the higher must be the pressure.

On the other hand, in the utilization of electric current, either for motors or for lighting, it is essential that the pressure shall not exceed certain limits, within which the apparatus can be cheaply constructed and economically and safely operated.

The conflicting demands upon the electrical system are, therefore, that it shall transmit current at a high pressure, and supply current for use at a low pressure. These conditions are met either by a compromise, involving the choice of the highest electro-motive force which is permissible for the apparatus in which the current is to be used, and its transmission at this voltage, or by adopting a system in which a transformation can be made between a high pressure employed in transmission and a low pressure for use.

The essential difference between alternating current and direct current is that the first readily permits of transformation from one pressure to another in a simple, cheap, and economical way, while the direct current does not admit of such transformation.

The direct-current system was the first in general commercial use. The first central stations employed this system, and it has been developed and exhaustively improved. The early direct-current stations found their field in lighting a compact territory adjacent to the station. The 220-volt three-wire system, which was suitable for supplying 110 volt lamps, was found to cover a limited radius without excessive cost for conductors.

The direct-current system is confined to a comparatively small area, which must naturally be a compact one in order to make the operation of a large station feasible. A system of this kind is not adapted to serving extended areas, such as are found, for example, in small scattered towns and outlying districts of cities, where there may be a considerable field for incandescent lighting.

The early alternating-current stations immediately entered this field. Their remarkable adaptation to the requirements of such a service is indicated by the fact that there is scarcely a town of average size which does not have its alternating-current central station ; and the larger cities, with extensive direct-current stations in their compact central portions, are usually fringed with alternating-current circuits.

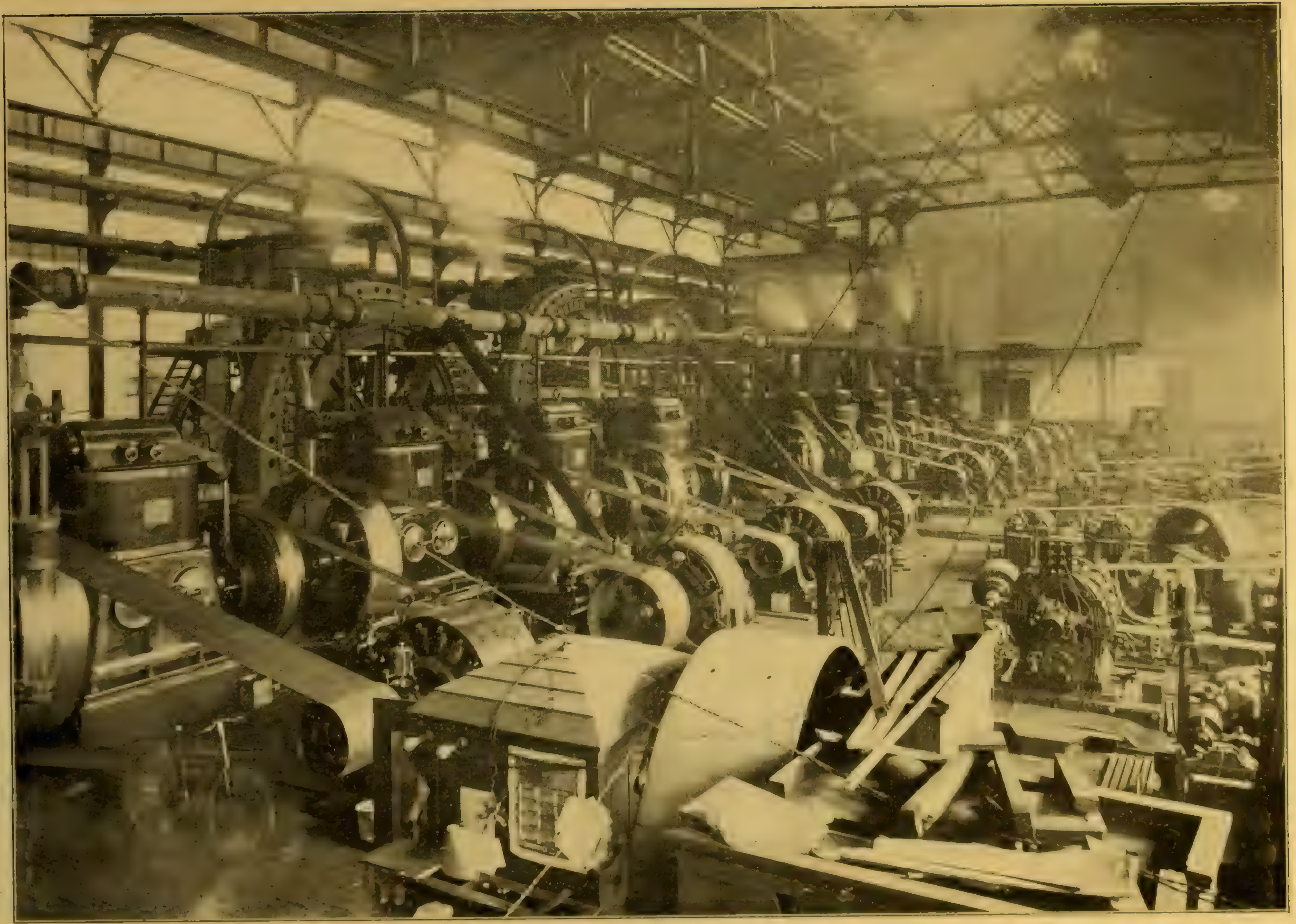
The alternating-current plan for general distribution employs 1,000 or 2,000 volts in the distributing circuits,—a voltage ample for distribution over distances of a few miles. The alternating current is also employed at higher voltages at greater distances, where longer transmission is necessary, as it is often from a water power which lies from ten to fifty miles from a city.

The early alternating current stations were, in most cases, used for comparatively small loads and for distances which were moderate for the voltages employed, so that a small loss in the conductors was secured at moderate cost. The advantages of the alternating current over the direct current, for this field, were so very marked that little attention was given to the loss in the circuits. It is not easy, therefore, except in some of the most recent installations, to find alternating-current stations which may be considered ideal, or constructed according to the best standards, whereas many of the larger direct-current stations exhibit the best results, probably, obtainable.

Within the last few years the alternating-current practice has received a vital modification in the introduction of polyphase, instead of single-phase, currents.

The early single-phase stations were devoted almost exclusively to incandescent lighting, and a most serious limitation of the single-phase system was that it had no motor by which it could serve power. The polyphase system accommodates the alternating-current motor, so that both light and power may be furnished by the same system.

The unique feature of the polyphase system is its flexibility. The pressure can be raised almost indefinitely for transmission, and reduced for consumption. The number of phases can be transformed at will, and it admits of ready conversion into direct current, at any voltage.



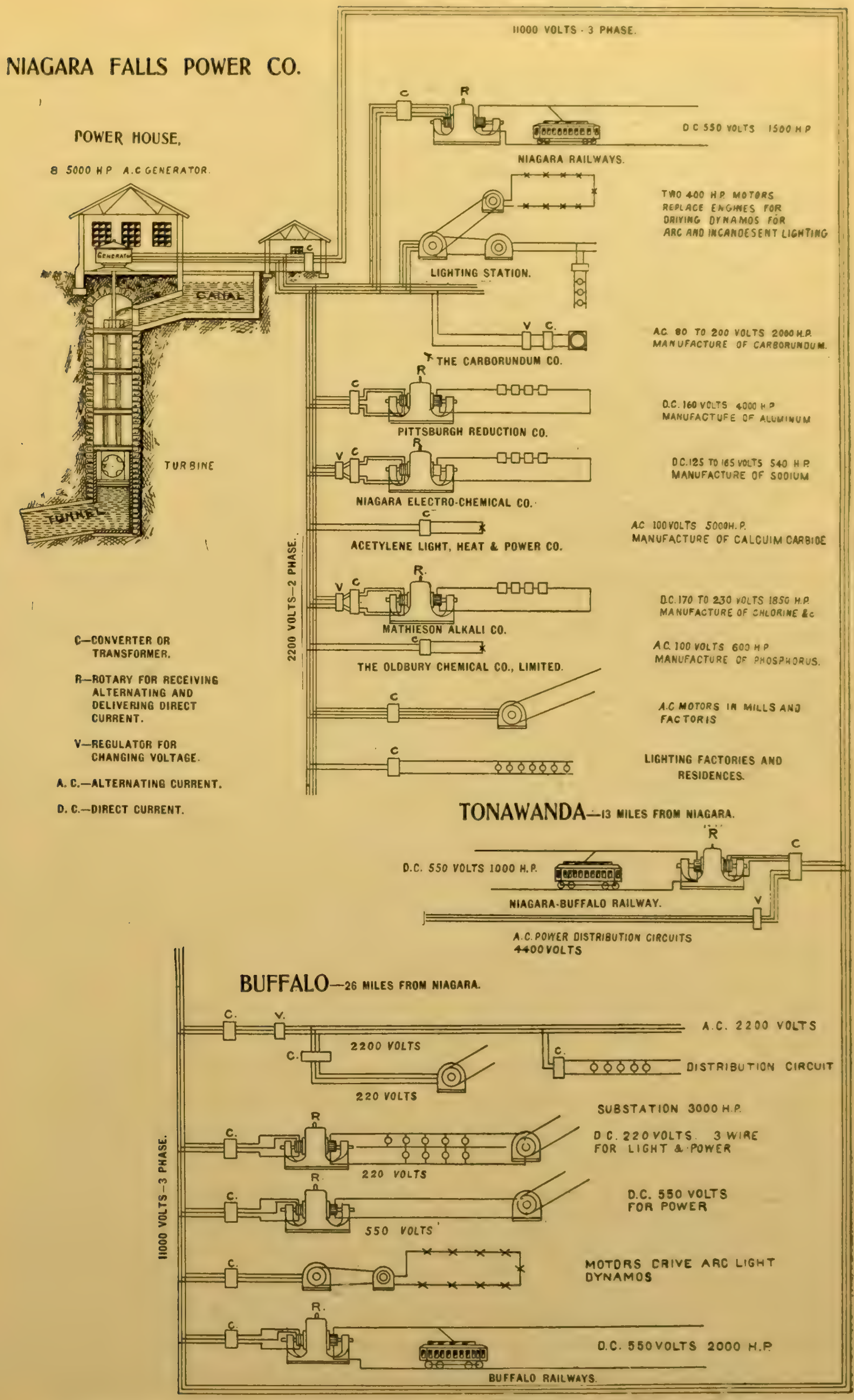
THE REVOLUTION IN CENTRAL-STATION APPARATUS. THE BELT-DRIVEN MACHINES ARE BEING REPLACED BY THE LARGE ALTERNATORS SHOWN IN THE REAR.

The possibilities of the alternating-current polyphase system were pointed out long ago. The variations, transformations, and wonderful flexibility, which were seen as possibilities, have been taking form during a dozen years of evolution in the design and construction and the methods of operating electrical apparatus, until these things have become practical realities. We need no longer point to diagrams of imaginary circuits and give theoretical explanations of what may be, but we can see what is now operating and is now being constructed. Some of the largest and most important installations which have been put into operation recently, as well as many of the largest undertakings which are at present contemplated, employ the polyphase alternating-current system.

It may be remembered that, some six or eight years ago, there was much discussion as to the system which should be employed in the large plant proposed for Niagara Falls. This plant was to be distinctively a power plant, and a large part of the power was to be used in the immediate vicinity of the generating station. The direct-current system had its strong advocates, who were very sceptical as to the applicability of the alternating current in a large power plant, in which there would certainly be a demand for a wide variety of service.

One needs to recall incidents of this kind to appreciate how rapid has been the advancement, and how complete has been the electrical development, of the last few years.

The various transformations of the current from the two-phase generators of the Niagara Falls Power Company are shown in the accompanying diagram. All the power from the 5,000-h. p. generators is delivered as two-phase alternating current, at 2,200 volts and a frequency of 25 periods per second. Four wires are carried directly from the generators to the surrounding industrial establishments. Current is transformed to low voltage, and then converted into direct current at 550 volts, for railway service. It is also converted into direct current at 160 volts, for use in the production of aluminum. At other places it gives direct current at variable voltage, adjustable at will from 125 to 165 volts in one case, and from 170 to 230 volts in another, to meet the varying requirements of electro-chemical processes. It is used as alternating current at low voltage for producing intense heat in chemical manufacture; in some places at a constant voltage, and in another at variable voltage. Regulators are provided by which 1,000 h. p. can be delivered in the form of 3,750 amperes at 200 volts, or 9,400 amperes at 80 volts, or any intermediate current and corresponding voltage. The current supplies induction motors, of 400 horse power and smaller sizes, some for replacing engines in a


NIAGARA FALLS POWER CO.
POWER HOUSE.
8 5000 H P A.C GENERATOR.
GENERATOR
CANAL
TURBINE
TUNNEL
11000 VOLTS · 3 PHASE.
C
R
V
D C 550 VOLTS 1500 H P
NIAGARA RAILWAYS.
TWO 400 H.P. MOTORS REPLACE ENGINES FOR DRIVING DYNAMOS FOR ARC AND INCANDESENT LIGHTING
LIGHTING STATION.
A.C. 80 TO 200 VOLTS 2000 H.P. MANUFACTURE OF CARBORUNDUM.
THE CARBORUNDUM CO.
D.C. 160 VOLTS 4000 H.P. MANUFACTUFE OF ALUMINUM
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NIAGARA ELECTRO-CHEMICAL CO.
A.C. 100 VOLTS 5000 H.P. MANUFACTURE OF CALCUIM CARBIDE
ACETYLENE LIGHT, HEAT & POWER CO.
D.C. 170 TO 230 VOLTS 1850 H.P. MANUFACTURE OF CHLORINE &c
MATHIESON ALKALI CO.
A.C. 100 VOLTS 600 H.P. MANUFACTURE OF PHOSPHORUS.
THE OLDBURY CHEMICAL CO., LIMITED.
A.C MOTORS IN MILLS AND FACTORIS
LIGHTING FACTORIES AND RESIDENCES.
2200 VOLTS—2 PHASE.
TRANSMISSION CIRCUIT.
C—CONVERTER OR TRANSFORMER.
R—ROTARY FOR RECEIVING ALTERNATING AND DELIVERING DIRECT CURRENT.
V—REGULATOR FOR CHANGING VOLTAGE.
A. C.—ALTERNATING CURRENT.
D. C.—DIRECT CURRENT.
TONAWANDA—13 MILES FROM NIAGARA.
D.C. 550 VOLTS 1000 H.P.
NIAGARA-BUFFALO RAILWAY.
A.C. POWER DISTRIBUTION CIRCUITS 4400 VOLTS
BUFFALO—26 MILES FROM NIAGARA.
A.C. 2200 VOLTS
2200 VOLTS
220 VOLTS
DISTRIBUTION CIRCUIT
SUBSTATION 3000 H.P.
D C. 220 VOLTS 3 WIRE FOR LIGHT & POWER
220 VOLTS
D.C. 550 VOLTS FOR POWER
550 VOLTS
MOTORS CRIVE ARC LIGHT DYNAMOS
D.C. 550 VOLTS 2000 H.P.
BUFFALO RAILWAYS.
11000 VOLTS—3 PHASE.

TRANSFORMATIONS OF CURRENT FROM TWO-PHASE GENERATORS AT NIAGARA FALLS.

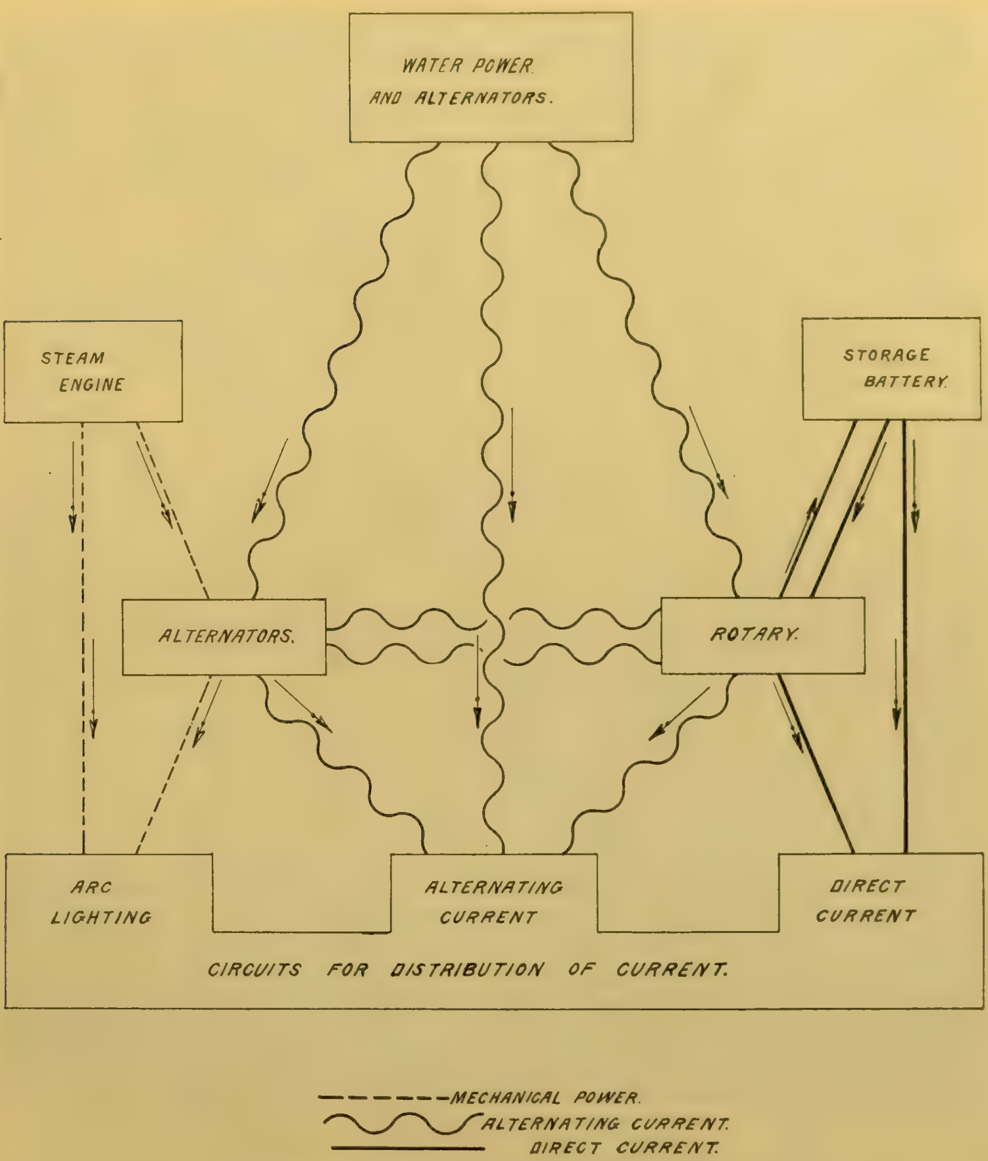
lighting station, others for doing various work in factories, sometimes directly at 2,200 volts, sometimes at low voltage.

The current is transformed into three-phase current at 11,000 volts for transmission to greater distances. At Tonawanda there are rotaries for delivering direct current to the Niagara & Buffalo railway, and there are distribution circuits for supplying electric current for power and light.

At Buffalo current is reduced in pressure and converted into direct current, at 550 volts, for street railways and for stationary motors; it is converted into direct current for 220-volt three wire distribution; it runs motors which replace engines in lighting stations for driving dynamos for arc-lighting and for high-frequency incandescent lighting; it runs motors in grain elevators and various industries, and supplies incandescent lighting.

We are not now considering the economic influence of electricity in touching manufacturing and industrial operations in so many and so varied ways, or the newness of the processes and the far-reaching importance of the products which have been made possible by the supply of large quantities of cheap electric power, or yet the magnitude of the engineering projects which are involved in this great power plant; we are considering simply the electrical system by which one set of bus bars is supplying electric power in nearly every form, and for practically every purpose to which electricity is industrially and commercially applied.

The transformations to which the polyphase alternating current is amenable, in a large plant, are seen at Hartford, Conn. There are two sources of power—a water power, ten miles from the city, which drives alternating-current generators delivering current through raising transformers to a three-phase 10,000-volt transmission circuit, and a steam engine, located in the city. This engine drives a countershaft, from which are belted a number of arc machines. The countershaft is connected to an alternating-current machine, which may be driven by the engine for supplying power to the alternating circuits; this machine, however, may receive current from the transmission line, and run as a synchronous motor, driving the countershaft, and arc machines. There are rotary transformers in the city, which receive alternating current either from the water-power station or from the steam station, and deliver this power in the form of direct current, which is supplied either to the 220-volt 3-wire distributing system, or to a large storage battery. The storage battery in turn may serve as a source of power, from which current may feed into the direct-current distributing system; or, passing through the rotary, it may appear in the form of alternating current, which may either sup-



PATHS OF POWER AT THE HARTFORD PLANT.

ply the alternating-current distributing circuits, or pass to the synchronous motor, and be used for arc lighting.

Either the water power or the steam engine, therefore, may supply either the arc circuits, the alternating-current circuits, the direct-current circuits, or the storage battery. The storage battery may, in turn, supply power to any of the three classes of distributing circuits. The storage battery is charged when the load upon the distributing circuits is small, and it discharges when the demand is greater than the capacity of the water-power station, thus enabling the turbines to carry a load some fifty per cent. above their maximum output. The battery is also a useful regulator for both direct and alternating cir-

ONE OF THE EARLIEST COMMERCIAL ALTERNATORS. A 300-LIGHT MACHINE OF 1886.

cuits, to prevent variations of voltage with varying load. The steam plant is a reserve.

These interesting relations may readily be illustrated by a diagram, which happens to take a symmetrical form, and which illustrates, in a striking way, the combination into one flexible system of classes of work which are, ordinarily, absolutely distinct, and it is interesting to note that the lines in the centre of the diagram, which bind together the different elements in the system, represent the polyphase alternating current.

In the past development of electric work each set of conditions has dictated certain requirements, and given rise to a specific system. The usual types of city central stations are as follows:

(1) 220-volt three-wire direct-current system, for lighting and motors.

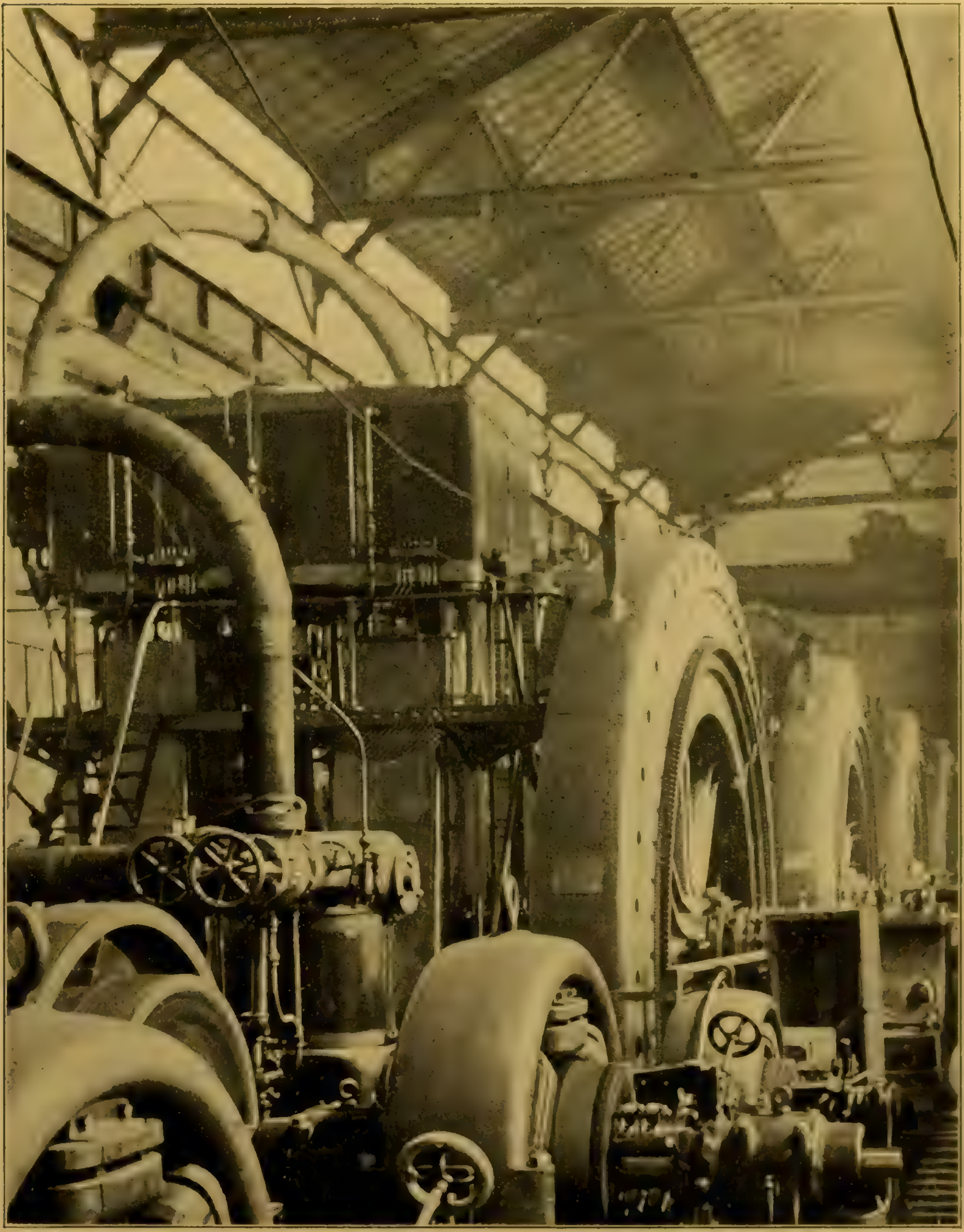
(2) 500-volt direct-current system, for street railway.

(3) 500-volt direct-current system, for stationary motors.

(4) Direct-current series system, for arc-lighting.

(5) Alternating-current single-phase system, for lighting.

(6) Alternating-current polyphase system, for lighting and power.



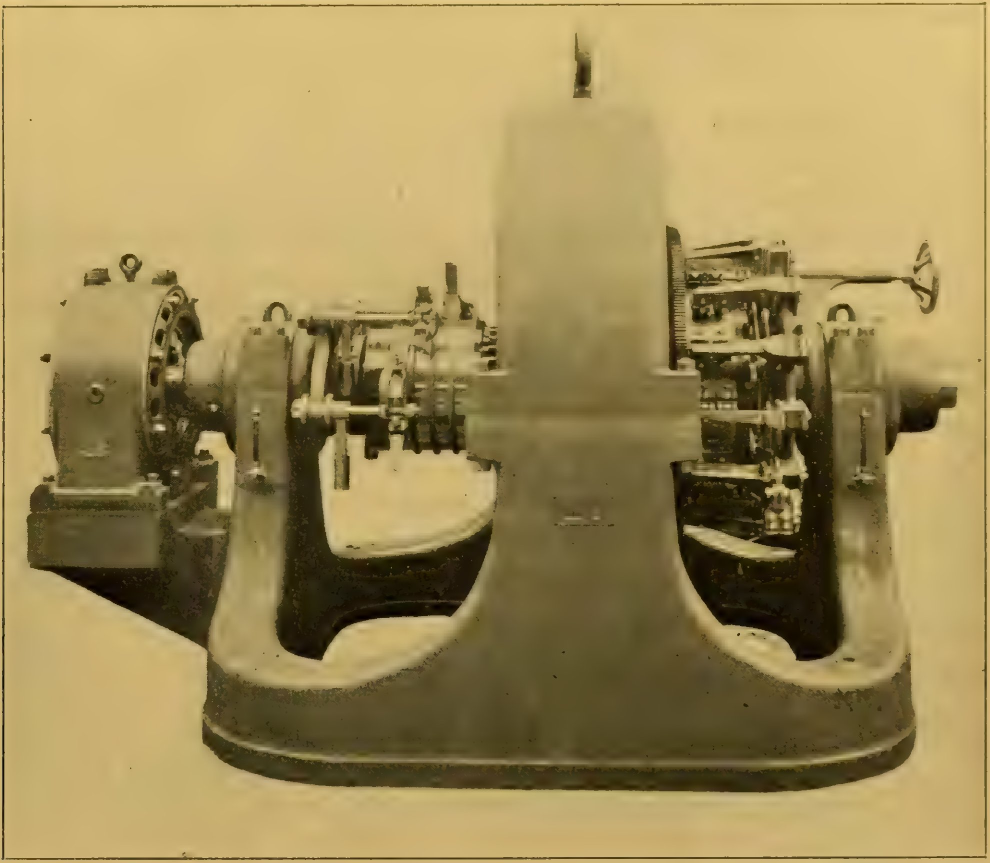
A MODERN CENTRAL STATION. FOUR 1500-KILOWATT TWO-PHASE ALTERNATORS, DIRECT-DRIVEN BY VERTICAL ENGINE.

It will be noted that, omitting for the present the last one, the various systems named are exclusive, both in the generation of current in the circuits to be employed and in the kind of service rendered. It is true that both 220 and 500 volts are used for supplying direct current for power purposes; but the two systems are distinct, in that one of them is combined with lighting and the other can extend to a much greater radius.

It is true that both alternating current and direct current are adopted for lighting, although the direct current is limited in its radius, while the alternating current is practically unlimited ; nevertheless, the various kinds of work require different types of dynamos, so that the same dynamo cannot supply either of several kinds of service. In general, this leads to the use of separate engines for each kind of work. The circuits from the station, where several of the systems are operated in one station, must be individual for each class of work.

The inefficiency, complication, and cost of operating some half-dozen different kinds of electric systems in this way are so apparent as to need no passing comment. The ideal of the central-station manager is to do away with small engines, small dynamos, and promiscuous circuits, to gain the simplicity and efficiency of large engines and generators, and to reduce the number of circuits from the station. Moreover, in many of the larger cities, the area is so great that 220-volt and 500-volt distribution require a considerable number of stations distributed throughout the city. The stations must be located in the centre of the districts which they supply, and this requires that power stations shall be placed in localities where they are undesirable, where real estate is expensive, where fuel must be hauled in wagons, and where condensing water is not to be had. The same reasons which combine to make large engines and large dynamos desirable, in a single station, make it also desirable to combine the power plants of many stations into one large station. A power station, placed in a city, must conform to the surrounding conditions; outside, it may be designed for the highest convenience and economy.

It is evident, from the illustrations which have already been given, that the means for combining the whole service of a large station into a single unit—or, again, for combining the power plants of many scattered stations into one single power plant—are made possible through the alternating-current polyphase system. The 220-volt 3-wire direct-current service can be supplied readily, through rotaries in sub-stations, located at the centers of distribution and supplied from a distant power plant. The 500-volt direct current for railway service can be similarly supplied. The same method may be used for obtaining direct current at 500 volts for stationary motors. Better, still, alternating current can be used directly for supplying induction motors. The direct-current arc machines can be driven by alternating-current motors, located in the sub-stations, or they may be placed directly in the main station with the generators. In the latter case, the polyphase current is not used for transmission, but serves as a convenient means for conveying the power from a large engine to a considerable number of small machines. In many cases, however, this system of arc-lighting can be replaced by the alternating-current arc lamp, which has points of decided advantage over the direct-current lamp.



ROTARY FOR RECEIVING ALTERNATING AND DELIVERING DIRECT CURRENT.

The alternating current may be used for the service that a single-phase system has been meeting, not only in distributing through distant scattered districts, but also in compact centers. The use of the alternating-current motor, and the construction of large and efficient transformers, have taken away much of the advantage which was formerly possessed by the direct current over the alternating current for distribution in compact centers, and the alternating current and direct current are close competitors for the supply of electric power in compact districts. So closely are the two balanced that a choice between them cannot be made without a specified reference to the local conditions, designed to determine the relative importance of the various characteristics in which the two systems differ.

The polyphase generator, however, is unaffected by considerations of this kind. It can supply either system of low-tension distribution; or, if the conditions demand, it can supply both simultaneously.

The polyphase generating system, therefore, permits the adoption of any or all of the following kinds of service, and, if demanded, it may deliver current to all kinds of service simultaneously:

220-volt direct current from rotaries and sub-stations, for light and power.

500-volt direct current from rotaries and sub-stations, for street-railway and stationary motors.

Low-voltage polyphase distributing circuits, supplied from lowering transformers through secondary mains, for light and power.

Low-voltage single-phase distributing circuits, for lighting.

Alternating current by isolated transformers, either polyphase, for light and power, or single phase, for lighting only.

Arc lighting, either from constant-potential direct-current or alternating-current circuits, or from arc machines driven by motors.

Special service requiring alternating current or direct current at any voltage.

The principal advantages to be gained by employing one main power station, in the operation of an extended system requiring distribution of direct current from a number of stations, are exhibited in the following table, showing the factors bearing directly upon the cost.

Table Showing Principal Items of Cost which are Increased or Decreased when a Main Power Station and Sub-Stations Replace Several Power Stations.

I. Costs which are increased by operation from a single station.
High-tension line from power station to sub-stations. Raising and lowering transformers for high-tension line. Rotaries in sub-stations.

II. Costs which are reduced by operation from a single station.

Real estate: A large station, where land is cheap, and small sub-stations, where it is dear, replace several steam stations where real estate is high.

Steam plant: A single station has larger units of less aggregate output, as the per cent. of reserve apparatus is reduced. Condensing engines usually replace non-condensing.

Generators. A single station has larger units, of less reserve capacity. The same generator may be used for any kind of service. Different types of generators are not required for maximum output and reserve for each kind of service.

Fuel. A single station in the suburbs can usually use a cheaper grade of coal, with less cost of cartage, and will require fewer pounds per horse power, as engines may be condensing and apparatus is usually more efficient. (This is partially offset by losses in sub-station apparatus.) If water power be available, the cost of power may be greatly reduced.

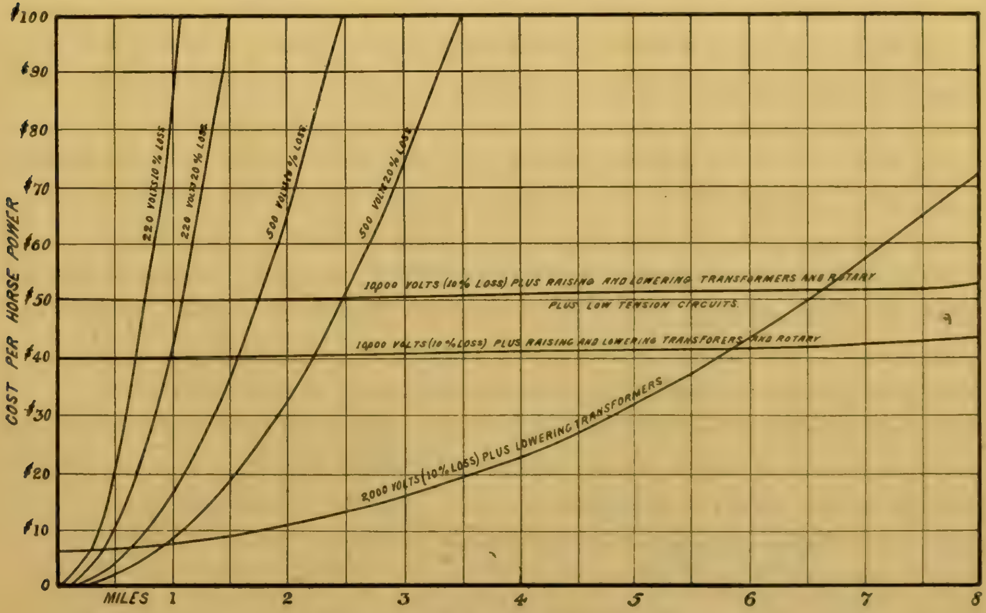
Attendance. A single station and several sub-stations require less attendance than several complete steam stations.

Distribution circuits. The number of sub-stations can be made greater than the number of steam stations which they replace. This reduces the length and cost of the distributing circuits.

The general relation between the first costs of different systems for conducting power from the generator to the consumer is shown by the accompanying curves. These curves are, of course, only approximate; the cost of conductors has been taken at about 15 cents a pound for copper, without reference to insulation; no allowance has been made for the middle wire of the three-wire system, and the cost of apparatus depends largely upon the size of the units used.

The cost for copper for 220-volt transmission and 10 per cent. loss is seen to be $21 per horse power for one mile and $85 for two miles. The cost is half as great when the loss is 20 per cent., but the distance for a given cost is increased only 40 per cent.

The cost for 2000-volt transmission includes a constant representing the lowering transformers. The curve does not include the secondary conductors from the transformers. If the distance be short,



CURVES SHOWING RELATIONS OF FIRST COST OF DIFFERENT SYSTEMS OF ELECTRIC-POWER CONDUCTION.

the cost is small. The lower curve for rotaries includes the cost of transformers, rotary, and 10,000-volt circuit. The upper curve includes the direct-current distribution circuits, assumed to have an average length of one-third of a mile, if the voltage is 220, and three-quarters of a mile, if the voltage is 500,—the loss being 10 per cent.

It is seen that the direct-current transmission is cheaper to install than the 2,000-volt alternating current with transformers, if the distance be less than about a quarter of a mile (the voltage being 220) or two-thirds of a mile (the voltage being 500). The cost of copper for 2,000 volts becomes excessive when the distance exceeds a few miles; for greater distances a higher voltage should be used.

The curves representing the rotary sub-stations show a high first cost. This can be justified only by economies in operation. A comparison between these curves and the 2000-volt curve for the alternating current throughout shows the advantage of the alternating-current distribution over that by direct current through sub-stations. Besides the reduction in first cost, the attendance at sub-stations is abolished, and the efficiency is increased.

The comprehensive polyphase system is not a new one, which discards all that is old, but it enables a combination into one system of the best in all others. This result is not so much the immediate outcome of novelty or invention, as of adaptation and engineering. The electrical developments of the last ten years are due not so much to the inventor as to the engineer.

The direct current is comparatively simple in theory, and was for a time far in the lead of the alternating current. The alternating current, however, complicated and intricate in its theoretical treatment, mysterious in its phenomena and interactions, is much the simpler in apparatus. The generator is a simpler machine, as it is burdened with no commutator; the transformation from one pressure to another is effected in an apparatus without moving parts, possessing as high an efficiency as that of any instrument by which energy is transformed; and the alternating-current motor, so long a phantom and stumbling-block, has now far surpassed its direct-current rival in mechanical simplicity, and general merit for almost every kind of service.

And the direct current, which once upon a time looked with disdain and ridicule upon its adversary as a feeble infant, doomed soon to perish by its own contortions, is now glad to receive its power from the rival which has so far outstripped it—happy that it has not itself been crowded out of existence.

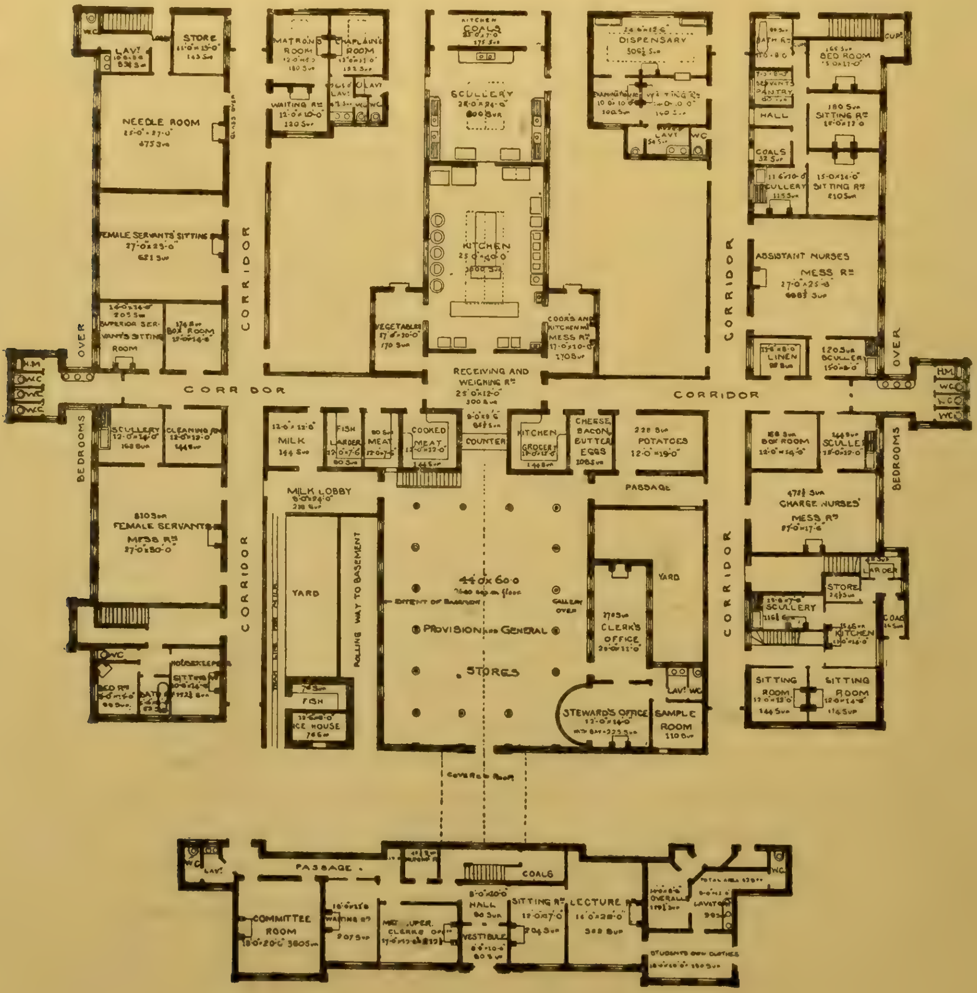
SANITARY PRINCIPLES IN THE CONSTRUCTION OF ISOLATION HOSPITALS.

By G. A. T. Middleton.

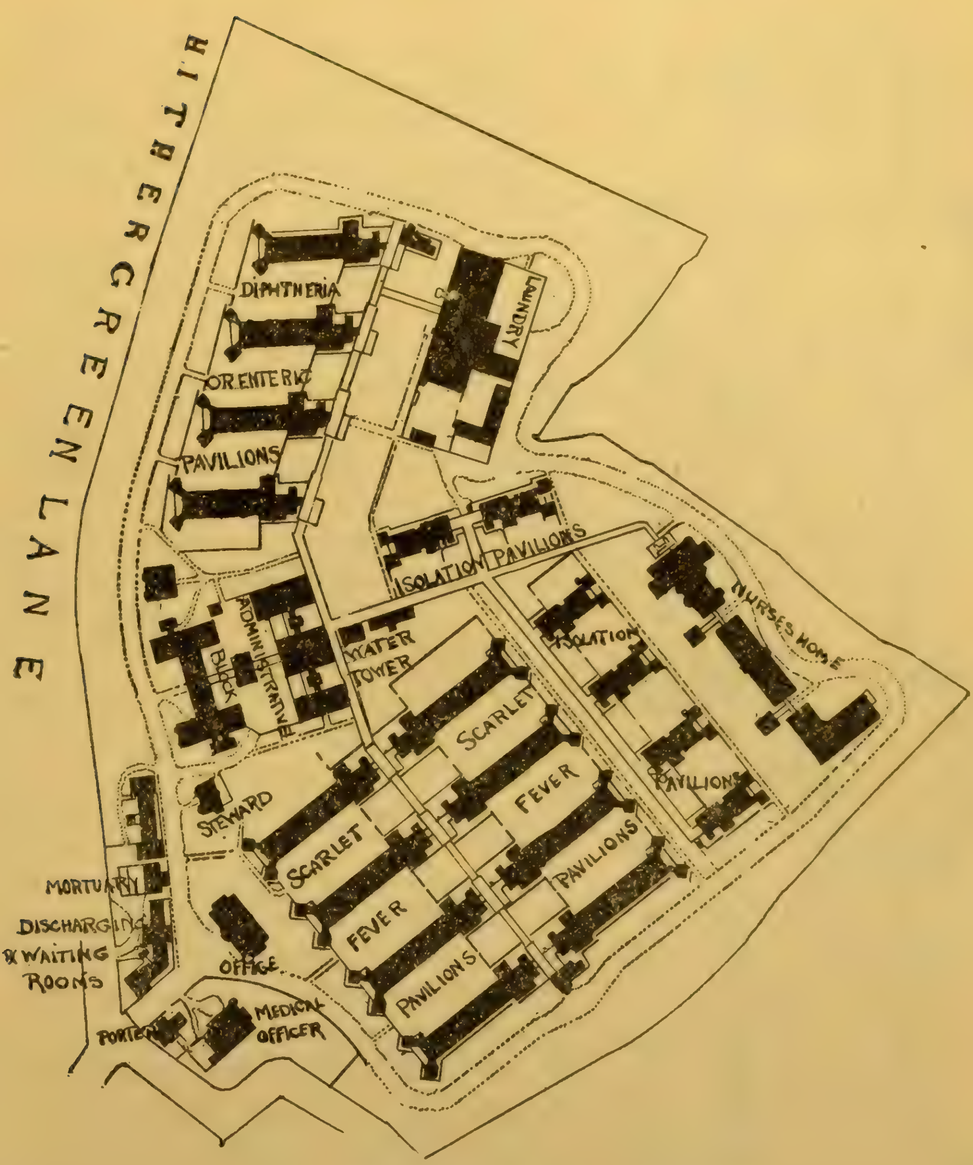
THE increasing attention which has been paid, during the last few years, to the study of infectious diseases, and the certainty of control which, it is found, can be secured by careful observance of sound sanitary principles in the design and equipment of suitable buildings for the treatment of patients suffering therefrom, has resulted, in England, in the erection of a large number of special hospitals for infectious cases. To these hospitals, which are maintained out of the rates, all patients suffering from certain complaints—notably scarlet fever and diphtheria—are compelled to be removed, unless the medical officer of the district is satisfied that thoroughly-efficient precautions are being taken against the spread of infection. Indeed, many people who can well afford all that is necessary to effect this assurance prefer, if cases break out in their homes, that the sufferers should be removed, so high is the reputation which these special hospitals deservedly enjoy. This is largely due to the perfection of the structural arrangements, giving each patient the greatest possible chance of recovery, while reducing the risk of contagion to a minimum,—a risk always present in a private house containing a case of infectious fever, however great the care taken.

To a great extent all hospitals are now planned upon well-understood principles; these are accentuated, with the introduction of but few new features, in hospitals for special cases. The pavilion system is universally adopted. There is usually a central block, forming, or near to, the main entrance, for administrative purposes, and containing the rooms for matron and medical officer and the kitchens; from this block range corridors, or open footways, to the various wards. As a rule, especially in hospitals of more than one story in height, the corridors, though open at the sides, are covered and placed one above another at the level of the various floors; in many general hospitals their sides are glazed, in addition, and sliding windows are provided, which can be opened at will. Where infectious disease has to be combated, however, the sides are preferably left open, so that free current of air may pass in all weathers, while, if the building be of one story only, even the roof should be omitted, as in Mr. Bishop's small hospital at Linslade. In large hospitals, like the Park Hospital (designed by Mr. E. T. Hall), a subway for the conveyance of pipes, electric wires, etc., well lighted and accessible at all points for the execution of repairs, is placed under the corridor. The two buildings just cited may be considered typical modern hospitals, one upon the smallest, and the other upon the largest, scale,—both from successful designs in recent competitions, and only now nearing completion.

The wards are almost always arranged in separate blocks with their axes as nearly north and south as possible, so that sunlight may enter at all hours of the day, and with sanitary annex at one end, detached from the ward by means of a short corridor with open window on both sides; the nurses' inspection room is at the other end. Wards are generally 12 ft. high in the clear, about 22 ft. wide for a double row of beds or 13 ft. for a single row, a minimum of 2,000 cu. ft. of air-space being provided for each fever patient. Beds are never placed in the corners of the wards, spaces for the use of doc-

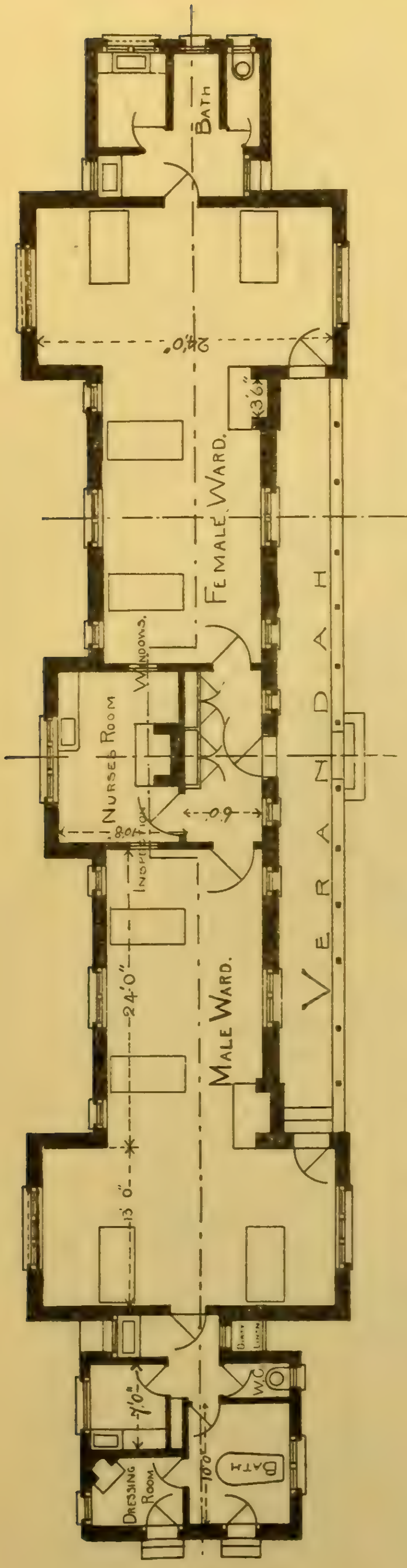


ADMINISTRATIVE BLOCK FOR A LARGE HOSPITAL.



THE PARK HOSPITAL. BLOCK PLAN.

tors and nurses being left on each side ; in fact, the corners at the southern ends are often canted and a window inserted, to admit direct sunlight at mid-day ; or, more rarely and only in small hospitals, Mr. Bishop's expedient of the T-shaped ward is used for the same purpose. Windows are arranged between the beds and opposite one another ; they reach up to the ceiling, and have the upper portion hung upon hinges to swing open between hopper side-guards. In this way no draught descends, and the hopper lights may be open in almost all weathers ; as a matter of fact, they are much more depended upon to provide ventilation than any elaborately-designed



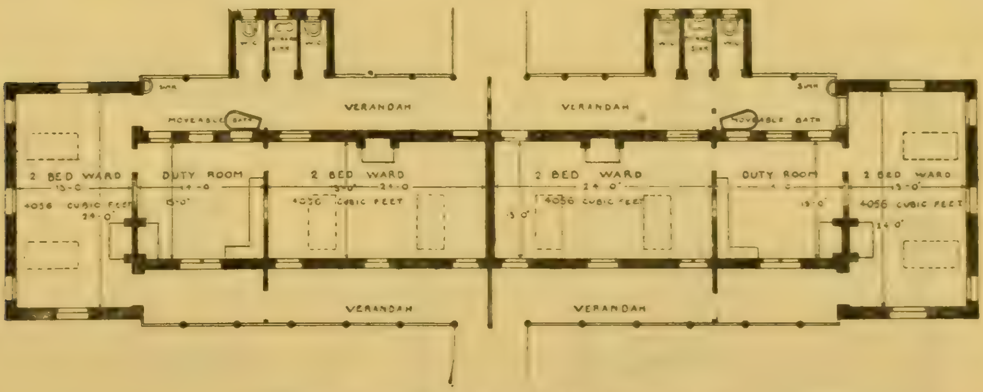
SCARLET-FEVER BLOCK, LINSLADE RURAL DISTRICT HOSPITAL FOR INFECTIOUS DISEASES.

system. In warm and dry weather the lower portions of the windows can also be opened, either as sashes or casements, and, the openings being opposite one another, a perfect through current is obtained. In small hospitals it is usual to form the windows on one side of the ward, as French casements, opening down to the ground and giving access to a verandah, roofed at the level of the transom below the hopper-light. This verandah is enjoyed by convalescing patients in fair weather, and can also be used for the purpose of giving bed linen and bedding a "sun-bath" occasionally. In large hospitals of more than one story this verandah is often arranged in the form of a balcony at the end of the ward.

In such a hospital, containing more than ten beds to the ward (twenty being the maximum number), there are frequently two sanitary annexes to each ward, entered diagonally, one being used for baths and the other for closets; the balcony just mentioned is then placed between the two unconnected corridors, which are themselves constructed as tunnels, with free air passage above and below.

In the sanitary annexes are placed closets (of the wash-down type, as a rule, with lifting seat), a deep sink for washing bed-pans, and a bath; each of these occupies a separate well-lighted compartment, and all, as in the ward, are so designed that a duster can reach every part readily. The bath is on rubber wheels, and, after being filled, can be wheeled to a patient's bedside, used, and wheeled back again to discharge over a trapped gully in the floor, discharging again to another similar gully in the open air. Of course, the drainage system must be perfect.

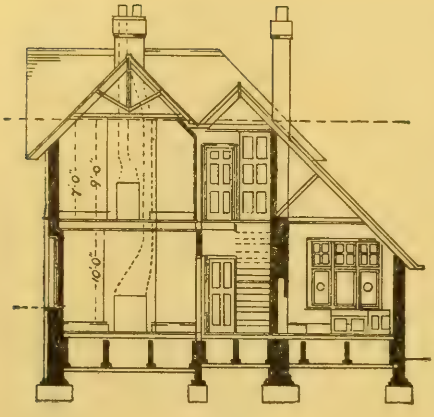
Two apparently minor, but really most important, points for the architect to bear in mind are, first, that floor, wall, and ceiling surfaces must be impervious and easily cleanable, and, second, that there must be no places where dust can accumulate. To mention the former is enough to secure attention to it; but the latter necessitates that there shall be no flat ledges or sharp re-entering angles anywhere, the junctions between floor and wall, and between wall and ceiling, and the corners of the room, all having to be rounded. Doors must be made without panels, fitting into circular rebates in the frames; key holes must be omitted, and all woodwork specially sectioned. There must be no spot, in fact, where a duster cannot get with ease.



A TYPICAL PAVILION FOR SMALL HOSPITAL.

Artificial ventilation, although, for the reason already stated, it is a comparatively minor matter, is always carefully attended to, with particular reference to its employment in inclement weather, when the windows can be only partially opened, or upon the very rare occasions when they have to be completely closed. In large institutions the fan system of injecting warmed fresh air is occasionally adopted; more frequently a simple arrangement of inlets and outlets is thought to suffice, the fresh air being admitted through tubes in the floor and warmed by passing round a fire, of the open English type, but specially constructed, either in the middle of the ward, or, in small wards, in one of the side walls, before being allowed to enter at about 7 ft. from the floor. A small inlet, usually admitting air at the normal temperature, is commonly inserted under each bed also, while the outlets are invariably at the ceiling level, either into upcast shafts (supplied with some patent exhaust or heated, to create a current, by means of a gas jet), or else into a supplemental chimney flue. It will be understood that the open fireplace is also trusted to act as a sufficient low-level exhaust.

For small wards in small hospitals the open fire is generally the only means of heating adopted, in spite of its admitted imperfections —among these the noise of replenishing the fuel being by no means the least; but, where the facilities and the means at command allow, steam, hot water, or hot air is preferred.



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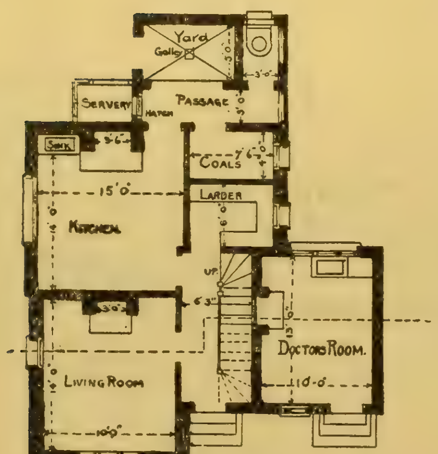
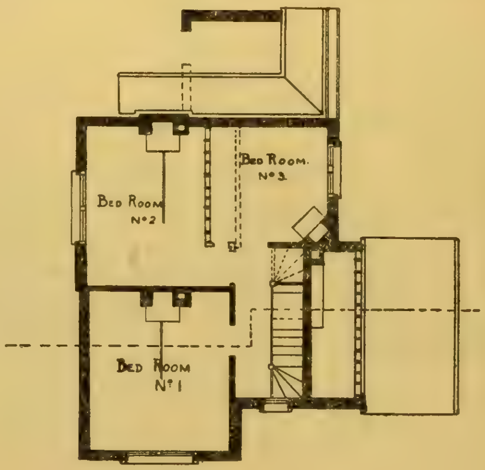


GROUND FLOOR PLAN.



FIRST FLOOR PLAN.

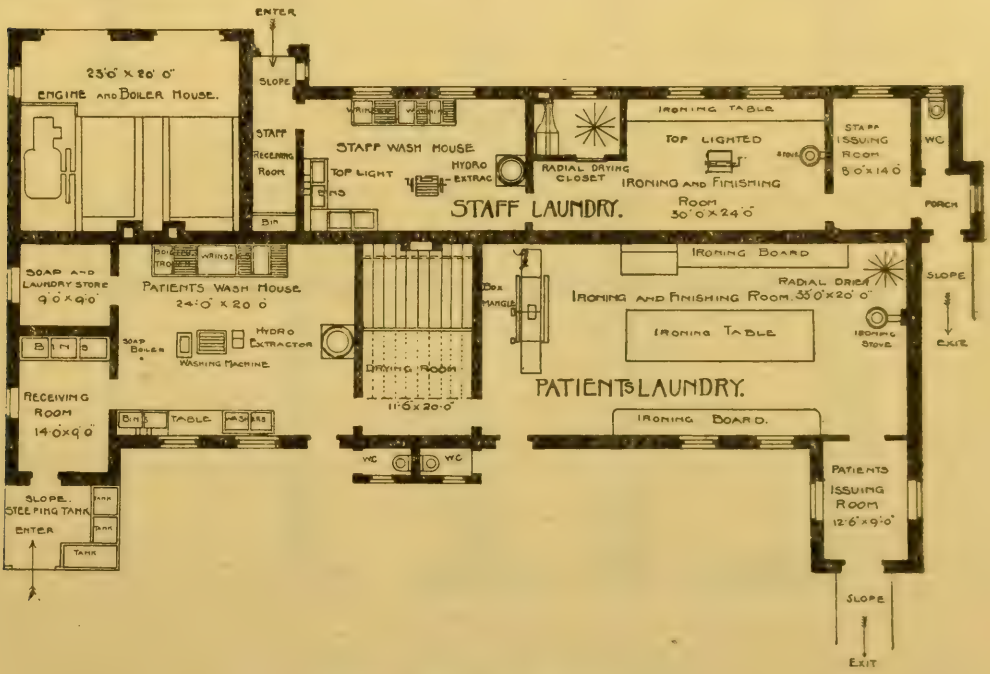
LODGE, LINSLADE RURAL DISTRICT HOSPITAL.

Similarly with lighting; though electricity is preferred, it is not always obtainable, and incandescent gas lights have then to be used instead. A light is, in either case, placed over the head of each bed, so located as not to irritate the patient and yet to give the nurse or doctor a good view of his features.

In the nurses' room, which always has a communicating window overlooking the ward, a fire is always kept burning, so that foods can be warmed or poultices made at any time. In connection with this room it is also convenient to have a store for clean linen, and a well-ventilated milk store; while a separate ward scullery is essential, as plates, cups, knives, etc., used by the patients in a ward, are never allowed to travel away from it, but are washed in the ward scullery at once, and stored there in racks.

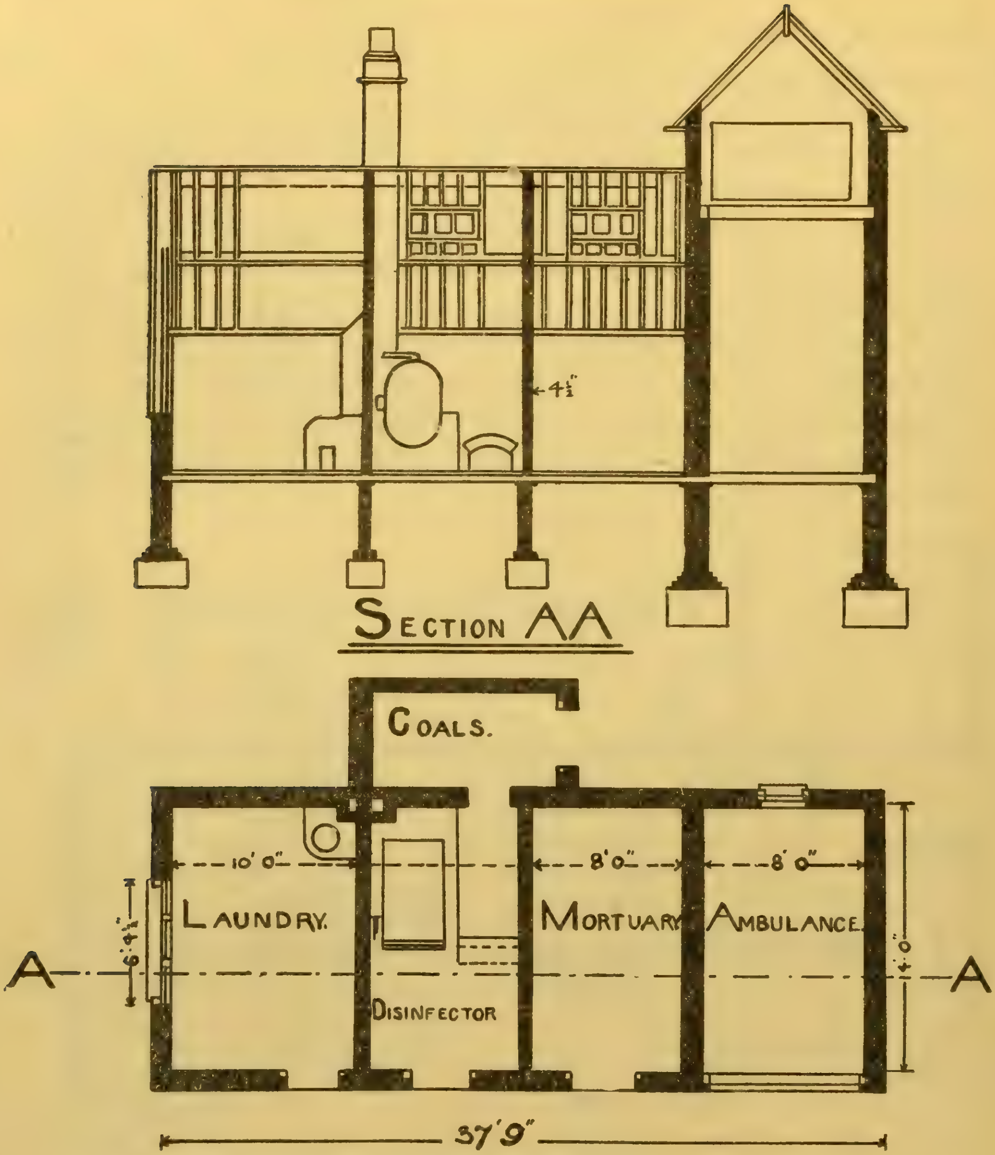
The food, it may be mentioned, after being cooked, is passed from the kitchen through a hatch to a freely-ventilated, but covered, serving pantry, and is taken thence by the ward nurse (who never enters the kitchen or comes into personal contact with the kitchen attendants) to her room, where it is cut for distribution to the patients.

Another important adjunct to the ward is the shoot, or bin, for soiled linen, through which it is thrown at once into the open air, after use, and taken away at regular intervals to the wash-house and disinfecting chamber; of course, in a large hospital, the laundry arrangements are perfect, and are distinct for infected and non-infected clothing.



LAUNDRY FOR LARGE HOSPITAL.

Special bath rooms, with dressing rooms, are provided for the daily use of the nurses, and for the discharge of cured patients. When nurses arrive, they enter the dressing rooms and change *all* their clothing, putting on clean things throughout and leaving their non-duty clothes. When they leave, after their spell of duty, they enter the medicated bath, leave their duty clothes in the bath room to be taken away and disinfected, and pass into the dressing room, preferably across a ventilated corridor, to put on their ordinary clothes. A precisely similar process is gone through with each patient just previous to discharge; provision for this must, of course, be made in the plan. In small hospitals the same bath and dressing rooms are used



LAUNDRY BLOCK, LINSLADE RURAL DISTRICT HOSPITAL FOR INFECTIOUS DISEASES.

for nurses and for discharged patients; in large ones separate accommodation is provided. The mortuary and doctors' rooms differ in no essential from those of an ordinary hospital, with the exception that no operating room is needed, and that absolute air disconnection between one part of the hospital and another is more imperative where infection has to be combated. Put shortly, the great modern cure for, and preventive of, infectious diseases, is fresh air—and plenty of it. To secure this without draught, to cut off by its means all that may possibly be infected from that which is healthy, is the architect's province.

The plans of the Park hospital are by Mr. E. T. Hall, those of the Linslade hospital by Mr. T. H. Bishop, and the typical laundry, pavilion, and administration block are from designs by Mr. W. A. Pite.

REVIEW OF THE ENGINEERING PRESS

The Launching of the Albert Bridge.

THE *Engineering Record* describes a novel method of erecting a long-span bridge at a point where false-work was impracticable.

The Albert Bridge is a structure on the Southern & Western Railway, and crosses the Brisbane river, in Queensland, Australia. It was originally built in 1875–76, but was washed out in 1893 by an extremely high flood, which overthrew all but two of the spans and the piers which supported them. Reconstruction was immediately begun upon a plan considerably different from the first one.

The new bridge consists of two double-track spans, each 340 feet long, which rest upon abutments and a central pier, all of masonry. The gage of the track is 3 feet 6 inches. The trusses are of heavy construction, with segmental upper chords, 41 feet 6 inches deep at the center panel, 21 feet 6 inches deep at the end-posts, and with a lateral dimension of approximately 50 feet over all. The bottom chord is 49 feet above ordinary high water, and 7 feet above the level of the flood which destroyed the first bridge.

We are forced to omit a description of the foundations, masonry, and details of the superstructure, all of which are extensively mentioned in the article from which we borrow.

Since the Brisbane river is a tide-water stream, it was possible to make use of this fact in the launching program, and the erection of the north span was therefore completed on shore, in a position which made its long axis coincide with the production of a line joining the centers of the pier and the abutment. The south span was erected on the two old trusses which remained in place and were used as false-work. "Ways" of heavy framed timbers, resting upon a carefully-levelled ballasting of gravel, were first constructed for the reception of the north span, which, during erection, projected 124 feet beyond the abutment over the river-side, and was supported for this distance by staging. Before the launching, the out-shore end was prepared to support itself as a cantilever for about 60 feet by means of temporary ties and compression members. When the time came for launching, the staging under this 60 feet was removed, and a large barge 45 feet wide, bearing a trestle for the purpose of receiving the bottom chord, was put in its place. There then remained a projection of 15 feet, which gave room for the end of the span to reach its seat on the pier in the middle of the river. The in-shore end was built upon a truck formed of heavy timbers, which were mounted upon four pairs of cast-iron wheels provided with 6-inch steel axles.

The process of launching was a simple one. At low water a barge of 800 tons' burden was floated under the out-shore end of the span, and in due time the flood-tide raised it into contact with the bottom chords. So little power was required to do the work that a 10-ton hand-winch, fastened to the deck of the old bridge and connected with the new span by cables, was sufficient to haul the barge and its load to the final resting-place in an hour and twenty minutes. Since the distance traveled was 225 feet, a comparatively rapid progress is shown to have been made. There was practically no chance of trouble, for the barge was moored in four directions, and during its movement the variation from the true line was but a few inches at most. Sighting-poles on the bridge, and 5-ton hand-winches, which were mounted on the barge, and to which the up- and down-stream mooring lines were attached, secured this result.

The floating into position of a completely-erected span is by no means a new idea, but the method by which the Albert Bridge was at the same time launched and towed is believed to be novel. Both at the Hawkesbury Bridge, in Australia and the Ohio Connecting Railway Bridge, near Pittsburg, spans of great length, considerably longer than the Albert Bridge, were erected near the shore and towed to their resting places on the piers. And again, at Jacksonville, Fla., four spans of 250 feet each were treated in the same way; but in all of the precedents which we have named the erection was completed on trestles located on the margin of the river, from which place they were moved, wholly supported on one or more barges.

To the designers and erectors of the Hawkesbury Bridge, the Union Bridge Company of New York and Mr. Charles McDonald, its representative, the real credit for the general idea belongs. In this instance the spans were 415 feet long, and they were erected at a distance of about 3000 feet from the bridge-site. The bottom chord had an elevation of approximately 45 feet above the water. Piles were first driven near the river bank, and sawed off several feet below extreme low water; upon them barges were then sunk with open sea valves, which were not closed during the construction of the iron-work. A trestle was built upon the barges, and on this the superstructure was erected. When all was completed, the sea-valves were closed at extreme low water, and the rise of the tide floated the mass from its bearings. It was then towed into its final position; in one case this took but an hour and three-quarters. The erection of the Hawkesbury Bridge took place in 1888.

In 1889 Mr. C. L. Strobel, then chief engineer of the Keystone Bridge Company, adopted the same plan at Jacksonville. This is worth noting only because it appears to have been the first time that the plan was tried in this country (although it originated in the mind of an American engineer), and because his success encouraged Mr. Strobel to apply the method at the Ohio Connecting Bridge at Pittsburg in the following year.

The conditions at Pittsburg differed from those obtaining at the other three places in many important particulars, There was no tide, and mechanical means were therefore necessary for floating the structure; heavy floods were likely to occur at any time, and at only a few hours' notice; the span was unprecedentedly large, 523 feet long and of unusual height above the water,—about 75 feet. All of these considerations led those in charge of the work to depart widely from the methods previously adopted. As before, pile foundations were driven and their tops cut off, but above, not below, the water-line. On these piles, which were arranged in bent, heavy I-beams were laid, parallel with the long axis of the bridge; the I-beams supported the trestle on which the span was erected, in the usual manner. Just before the time of floating, coal barges of ordinary construction were placed under the trestle and between the pile bents. The barges were then pumped out, taking the weight of the trestle and span by means of the I-beams. They were then towed into the stream, swung around parallel with the line of piers, and, after reaching the proper position, lowered into place by flooding the barges, which were afterward sold to carry coal down the river.

In view of the perfect success attending each of these operations, it is somewhat surprising that more extended use has not been made of the general idea, which must be better in many cases than the fixed-trestle plan.

Electrically-operated Turntables.

An interesting application of electric motive-power, which seems to be comparatively new and of some promise, is touched upon by *Engineering News* in its description of a motor of special manufacture for operating a locomotive turntable. This particular device, called by the builders an "electric donkey," is of 10 h. p. and weighs 3,700 pounds. The power necessary to turn the table, carrying a 100-ton engine, is stated to be ½ h. p. per hour, and is applied through a single traction-wheel running on a circular pit-rail. An earlier issue of the same journal contained a description of a similar contrivance installed by the Chicago, Milwaukee & St. Paul railway, and other installations of like character, often of home manufacture, have been made by other roads.

One is just going into operation in the Erie railroad yards, at Jersey City, and it seems to be a useful and readily-practicable substitute for cruder and less convenient power-applications in many railway yards. No information is given concerning the connections by which the current is carried to the motor, but this is not a point presenting any difficulty.

The motor illustrated is apparently independent of the turntable, and moves it by simply pushing against the end.

Electrical Consolidations.

THE consolidations which have taken place between electric companies in the past are overshadowed by that which became of public knowledge in September. The absorption of the Walker Company by the Westinghouse Electric and Manufacturing Company was one of those announcements which, although coming as a surprise, are not surprising, because of their perfect reasonableness. A healthy amount of competition is as necessary in the electric field as it is in any other, and, conversely, too active competition is as damaging both to the manufacturer and to the purchaser.

In this case a new company (new as an electric company) entered a department of the industrial world which was already filled to overflowing, and brought with it little in the way of new equipment or ideas; but it had a consistent desire to do business. As a necessary preliminary, prices were cut on most staple articles, and, as a necessary result, the market was turned upside-down for a while. But the amount of business to be done was not increased, while the selling expenses of the older companies became heavier, almost in proportion to the added violence of the competition. This did, and always will, work in the following way: More competition, more agents; more agents, less profit; less profit, less progress.

It is as clear as an algebraic equation, and, like an algebraic equation of many quantities, may be solved in two or more ways; but, whether it is reduced to its simplest form by elimination (as in the present instance) or by some other method, the answer will always be the same, if the values of the elements are properly construed.

The public is probably more vitally interested in the prosperity of its great electrical companies than in almost any other line of industrial activity. Not because the rights of stock-holders,—although even that is of no small importance, now that the investor is allowed to hold up his head,—but because it is through the electric companies themselves and the efforts of their servants that we must look for advances in their great field.

When the discouraging failures, the costly experiments, and the splendid successes are duly regarded, there is no longer a question as to where the public advantage rests. The purchaser of an electric motor buys not only a device for converting energy into work; he also buys the material embodiment of the thoughts, the brains, the labor, of hundreds of brilliant and devoted minds. And have these things no pecuniary value? We think they have. But we may safely leave the moral side of the question to take care of itself, for it will surely come to its own in time.

Inventors and investigators in pure science are increasingly allying themselves with those aggregations of capital called companies, where they are protected from the scramble of the daily bread-winner and are encouraged to follow each his natural bent, without anxiety as to the present or the future. Under these circumstances they are frequently enriched by the same efforts which, if applied independently and without other support than their own means, would have resulted in actual starvation. But this is only a small portion of the expense which a progressive company must meet. Discarded devices which are obsolete before they are ready for the market, and others which are out of date before their sale can be made a source of profit; material and labor which are consumed in experiments, and in attempts to improve existing machinery,—all of these go to make up an immense annual charge, a charge which works directly for the benefit of the public, and which must be currently met. If the public is to enjoy the advantages which accrue through this state of affairs, they must expect to pay for them, and they cannot be paid for except by generous treatment. The sort of buying which is right and proper when railway cross-ties or paving-blocks are to be purchased would be ruinous if applied to most classes of built-up electric material.

It is startling to look back twenty-five years and note the progress which has taken place in shop-practice, in the multifarious details of our acts and the things which attend upon our bodily comfort, a large part of them brought about by the men who have spent their brains or money in electrical research. If, then, so much has been accomplished in so short a time, what limit can be placed upon the future under favorable conditions? The things which have been done are as nothing to what may reasonably be expected, if the Teslas, the Kelvins, the Crookes, the Röntgens, and their co-laborers are generously encouraged.

Water Meters in Municipal Supply.

One of the most serious problems to be contended with in municipal engineering is that of water supply, involving as it usually does either costly aqueduct construction or extensive pumping plants; and when in addition to the expense of transportation the water must also be freed from impurities, the magnitude of the task for a great city becomes apparent.

When to the supply of water really needed for daily use there has to be added a large percentage for waste it is not to be wondered that water-works engineers are beginning to demand that some bounds shall be set upon the demands of a careless public and that some reasonable control of the quantity of water supplied shall be maintained.

Apparently all attempts to cause people to refrain from wasting water are unavailing unless some mechanical check is imposed, and the only recourse is the introduction of meters.

There has always been a great opposition to the use of any system of charging for water by measure, the general impression being that the consequence would be such a miserly use of water as to interfere with personal cleanliness among certain classes of inhabitants, a liberal use of water being rightly regarded as one of the most efficient preventives of disease. This, and several other misconceptions are well met in a paper recently presented to the Engineers' Club of Philadelphia by Mr. John C. Trautwine, Jr., the Chief of the Bureau of Water of that city, in which the popular errors about water meters are discussed and shown to be wholly unfounded in fact.

The volume of water supplied in Philadelphia is more than twice as much as there is any reasonable necessity for pumping, it having now reached the absurdly extravagant quantity of over 200 gallons per day for every man, woman, and child in the city, and yet there are numerous well-founded complaints from many quarters of insufficient supply and low pressure. "The reason is not far to seek. It is perfectly well-known that more than one-half of all the water pumped is wasted, flowing off into the sewers without benefiting either those who waste it—or the sewers." This waste is of various kinds, much of it being due to the leakage of imperfect faucets and other appliances, but a large amount of it passes through outlets which are permitted to run continuously when the water is only occasionally required, and such wastes, while made by only a small portion of the community, are now charged to, and paid for by all. Thus in one district in which a house to house examination was made, in 142 houses 22 appliances were found leaking slightly, and 32 were running steadily, the average consumption being 222 gallons per head per day, of which but 30 gallons were used and 192 gallons wasted.

In proposing to stop this state of affairs by the introduction of meters Mr. Trautwine recommends that the meters be applied, not to all dwellings, but only to those where outrageous waste is found to be going on, while the temptation to excessive economy can be prevented by the introduction of a system of minimum charge; this charge being so proportioned that the consumer will have drawn all the water he can possibly use and enjoy, together with a fair amount of waste besides, long before the meter reading has reached this minimum charge.

Much of the objection to the use of meters would disappear if the general consumer could be brought to realize that he is now paying for other people's wastage. It is a difficult thing for a man to grasp the extent to which water can leak through a comparatively small opening. An actual measurement of a slight trickling leak in a bath-room faucet showed an escape amounting to nearly 70 gallons per day, and yet many such leaks, which would be promptly repaired if meters were in use, are permitted to continue dribbling day after day for twenty-fours hours a day, simply because it is too much trouble to put in a new washer. With proper regulation of waste much of the money now required for the pumpage of an absurdly large supply could be used for filtration and improved distribution and the gain to the community would be beyond computation.

In comparison with the extravagantly large supply of over 200 gallons per head per day which Philadelphia has reached under the present system of waste, it may be of interest to note some figures of leading cities in England.

In Liverpool, for the supply of which the great Vyrnwy dam was built, the present supply is 25 gallons, and the maximum future supply for which provision has been made, 77 gallons per head per day; for Manchester the Thirlmere works now supply 20 gallons per head per day with an ultimate capacity of 100 gallons; while for Birmingham the new works now under construction to bring water from central Wales are to give an immediate supply of 57 gallons, and an ultimate one of 157 gallons, it being assumed in all three cases that the population remains stationary.

Mr. Trautwine concludes his paper with a number of reports from cities which have introduced meters, and in all of these the original opposition has vanished, while the wastage is stopped and the pressure increased, users finding that the care which the measurement of water compels them to keep over the leaks and other sources of waste, is trifling compared with the advantages gained.

In regard to hardship to manufacturers the low price, about one cent per ton, can hardly be considered a hardship, but if it is thought desirable to offer cheap water supply as an inducement to manufacturers this can be done as well with as without meters, since the meter does not fix the rate but only substitutes the payment by volume for the payment by time.

A New Movement in British Ship-Building.

UNDER the heading "An Ineffective Boycott" the *American Machinist* chronicles an incident which may have a wider significance than that which would attach merely to another failure of a generally discredited method of industrial warfare. It refers to the "proposed boycott of Harland & Wolff, the shipbuilders, of Belfast, because they refused to lock out their men, with whom their relations were entirely satisfactory, during the fight of last year. It was proposed to refuse to sell to them any shipbuilding material, evidently with the idea that, if British plate-makers, etc., refused to sell them material, they would have to go out of business. It does not seem to have worked that way, however. Last May a consignment of the largest size of ship plates were shipped from Pittsburg to Harland & Wolff, and it is stated that at least 800 tons more in plates 28×5 feet are being made by the same Pittsburg firm for the same destination. American pig iron is also being shipped there, and both plates and iron are laid down in Belfast at lower prices than they can be obtained from the manufacturers in the west of Scotland, who have previously supplied the demand."

A Spanish proverb refers to certain homely occupations in which "the beginning is everything." The principle often applies to the distribution of trade. A movement which appears to have in its favor the arguments of economy and expediency is delayed until it is forced by necessity, but, once originated under this pressure, the realized satisfaction of the new experience and the acquired inertia of the new movement combine to oppose and make doubly difficult the reversion to the original status.

It would be rather strange if the tactics resorted to by the British masters in a struggle to put themselves abreast of outside competition should actually result in advancing their rivals. But competition is the begetter of improvement, and the incident will spur the British iron- and steel-maker to fresh enterprise.

Asphalt as a Municipal Improver.

THE press of September announced a meeting of the National Road Parliament at Omaha on October 8 in the grounds of Trans-Mississippi Exposition. From this meeting there should arise a movement of gigantic proportions, and full of promise for the good of the United States at large.

To one who has spent the last thirty years in a series of movings from one to another of the large cities north of the Ohio river and east of the Mississippi river, who has lived in seven of them for periods ranging from one to eight years, and who has visited nearly all of them at frequent intervals, there is given a basis for comparisons which is interesting historically and instructive as indicating the probable line of development.

A stay in Chicago which began in the spring of 1866 was suddenly and unexpectedly terminated on October 9, 1871, by the great fire,—a residence which was never renewed, though the city continued to be a sort of second home for many years. During the five years of actual residence the population increased and the city enlarged its boundaries, but there were no external signs of improvement. Pine boards formed the almost universal side-walk, and for pavements (where there were any) pine blocks laid on rough boards were made to serve. It was at this time that the grade of the city was raised twelve feet, and, except for a few main streets, the foot-ways were on trestles which were interrupted at every intersection with a flight of stairs on each side of the roadway. This, it can be seen, did not add to the beauty of the city, and the awkwardness was increased by the heterogeneous character of the buildings, which were of all materials, but mostly of wood, and of no style of architecture; quite a moiety were several feet below the level of the street.

Lincoln park had but just been begun, and for half a mile north of what is now the entrance it was an abandoned waste,—a favorite hunting-ground for boys and men who were satisfied to shoot sandpipers. The Calumet marshes, too, which are now the site of Pullman and South Chicago, were the haunts of many sorts of game, even including deer, at least as late as 1875. In very truth, there was excuse for the prophesy, seriously made, of a Bostonian who shared in the hegira on the day of the fire, to the effect that "in twenty years Chicago would be a wilderness, and the wolves would be howling through what had once been her streets."

Cleveland was the next stopping-place, and here the conditions were somewhat better, for the place was older; but even in that city, which was able to boast of its old families, there was no pavement worthy of the name in 1872, nor was there for many years after.

Pittsburg, Buffalo, Detroit, Rochester, and Toledo gave the same evidences of public indifference to appearances, although some were better than others. But the pavements were universally bad, the architecture was beneath contempt, and not more than a half-dozen really handsome houses were to be found in the whole list.

It would be interesting to know exactly what force has brought about so great a change in American cities. It has not taken place greatly in the smaller towns, and it therefore seems likely that the cities contain some element not often to be found outside of them. An increase in wealth will not account for it, since there has been no such increase *per capita* as is at all commensurate with the improvements which have taken place; for that matter, wealth alone could not bring it about. It must first have been desired, and the real question is what created the desire.

To ascribe the change to a cause, at first sight, so remote as asphaltum pavements may perhaps strike the reader as ridiculous; but let us consider. A badly-paved street cannot be made to look clean and remain so, except at a considerable and constant expense; and, unless a street looks clean, it will not look well. The very hopelessness of the task caused it to be neglected. But, with the modern well-constructed asphaltum pavement, a highway came into being which could be cleaned at a reasonable cost, and therefore was cleaned. The first of these pavements in any city must have had its powerful and individual effect on those who saw it, and consequently on its neighborhood.

In all of the cities mentioned there was the same awakening, closely following the introduction of permanently smooth pavements,—an awakening which soon possessed the whole body, and grew in strength as the possibility of satisfying the demand became more evident. Then came the inevitable. Mr. A. repaired his fence and bought a lawn-mower; Mr. B. not only did that, but painted his house too; Mr. C. painted his house, and added a bay-window; each, not satisfied with emulating, but striving to surpass, his neighbors, until at last Mr. D. and the rest of the alphabet rebuilt entirely, on plans provided by an architect,—for the contractor and builder could no longer rise to the occasion.

It is not intended by this argument to show that there have been no other causes at work towards this end; but, in view of what has happened in so short a time, the conclusion is unavoidable that smooth pavements have been a principal reason for the change, the magnitude of which could not have existed and continued without them as a governing factor. In each of these cities the general improvement followed and did not lead the construction of good streets, and the statement is probably true of the other cities in America.

Incorrect Indicator Practice.

A CORESPONDENT of the *American Machinist*, in a recent issue of that journal, calls attention to the error of assuming that the closed cycle obtained from one end of the cylinder truly represents the action of the steam as it should be conceived and studied, and maintains that the forward stroke on one end of the cylinder should be considered in connection with the exhaust action going on at the same time on the opposite side of the piston.

The whole subject is well worthy of study in the manner in which the *American Machinist* has presented it, and undoubtedly forms an argument in favor of continuous indicator diagrams. It is hardly correct, however, to consider that this view of the subject is now presented for the first time, or that the ordinary manner of considering the indicator diagram is a "universally" incorrect way. More than twenty years ago the well-known German engineer, Herr Paul Kauffer, only recently deceased, called attention in the pages of *Dingler's Polytechnische Journal*, to the facts now published in the *American Machinist* and a translation of his paper appeared in the *Journal of the Franklin Institute* for July, 1877.

As Kauffer put it in 1877, "every diagram consists of a curve of work and a curve of resistance, and these two curves are not traced at the same time; but, for example, the curve of work is taken in the passage from left to right, and the curve of resistance in the return from right to left. In order to indicate a working cylinder, I use, wherever it is possible, an indicator on each end of the cylinder, and it was the analysis of just such a case that first showed me the necessity of making the correction." This was followed by indicator diagrams almost identical with those in the *American Machinist.*

The *Machinist* therefore scarcely can maintain that the less correct practice has gone "entirely unchallenged," although it is not undesirable to have attention again called to the fact that some users of the indicator do not take the resistances into account in the order in which they actually occur.

The Metric Propaganda.

It would be difficult to select for discussion an abstract subject of more importance at the present time than is the metric system, and it would be equally difficult to have it more rationally or concisely presented than is done by Mr. Edward Grafstrom in the *American Engineer*. He appears to be well acquainted with the efforts which have been made to introduce its use in the United States, and does not wholly approve of them. That is, he believes too much reliance has been placed upon the ability of congress, by making laws, to cause the adoption of the system by the people at large, and that this concentration of purpose has interfered with directing the movement into other and more promising channels. He goes further than this, however, by stating that congress has apparently done nearly all that is in its power already, by passing laws legalizing the use of the meter.

The main point to be considered is: how is the work to go on? And in this Mr. Grafstrom's experience is of value. He tells us that he lived successively in two countries during the transition from the old plan to that of the metric system. In one of these countries the time allowed for the change was eight years; in the other, ten years; and the methods employed by the respective governments were practically the same. In all of the schools (which were under full government control) the metric system was taught before the children were instructed in the complications of the prevailing tables, which they consequently approached with a substantial prejudice. This was the first step. Following it came the addition of metrical distances to mile-posts and station and other railway signs. New foot-rules, scales, and balances were graduated on both systems; applicants for positions in the civil service were examined in the use of the new system, and private employers soon began to require the same knowledge.

To show a familiarity with them, and to ask in the shops for a meter of silk, a kilogram of coffee, or a liter of beer, soon became a fad, until at the end of the fourth year the public found themselves to all intents and purposes, on a meter basis. And this was done without a single compulsory step to inconvenience them. At the same time, the manufacturing industries had been quietly, but steadily, preparing for the change.

The ruling power had decided that the metric system was the best, and it was then necessary only to fix upon the least troublesome way of bringing it into use,—a comparatively simple proposition. But in America the initiative which makes any such course possible is lacking and conditions favorable to such a plan are not likely to occur; so the problem must be solved in a totally different way. Mr. Grafstrom thinks that it can and must be done through a gradual education of the voting masses, leading up to a demand for the change on their part.

This seems a hopeless plan, and would certainly abort unless there were some stronger force back of it than is now apparent. For many years the various scientific societies have proposed, discussed, and resolved upon the adoption of the metric system in the United States; sometimes with a bare majority in favor, often with a large majority against concerted action, but never with that enthusiasm which is essential if an argument is to convince or a position is to be maintained.

That which appears to be most needed, therefore, in order that their dormant interest and energy shall be aroused, is a martyr, and to be a martyr one must first be an enthusiast. Prof. Mendenhall and a very few others with him have done splendid work; they have been the authors and movers of practically all that has been accomplished so far. But the martyr, the enthusiast, the bore who will talk his subject in season and out of season, who will ride his hobby through the halls of the technical societies, that man (or those men, for, the more they are, the sooner will the struggle be over) has not yet arisen; but he is sure to appear sooner or later, and, when he comes, he will beget others. Then the end will be in sight.

THE BRITISH PRESS

Ships of War in Action.

AMONG the many conflicting and contradictory accounts of the naval actions of the Spanish-American war it is refreshing to turn to a very clear and apparently impartial article in *The Engineer*, compiled with much labour from official and press reports and summarized with skill and judgment.

Commencing with the battle at Manila, and including the affair of the Winslow at Cardenas, the landings at Baiquiri and at Guantanamo, and the torpedo-boat manœuvring at Santiago, the study is completed by a consideration of the final engagement at Santiago and the destruction of the Spanish fleet, and the work done and the damage sustained by the various vessels are carefully analysed.

The net result of the two months' active naval warfare between the battle of Manila, on May 1, and the destruction of Cervera's fleet outside of Santiago, on July 3, points to a continuation of the policy of building sea-going battle-ships and armoured cruisers by all the ambitious naval powers of the world, the gun-fire on both sides having demonstrated that the ordinary plating of unarmoured ships offers no obstacle tó the direct fire of common shell timed to burst in the interior of the vessel. No harm, however, was done at any time to the armoured sides of the American battle-ships, although they were struck several times by Spanish shot and shell.

Apart from the question of ships, there can be no doubt that the superior skill of the American sailors and gunners had much to do with the result. Not only was this shown in the matter of marksmanship, but also in the important work of extinguishing fires on the American vessels, such fires on the Spanish ships being permitted to get beyond control. The principal weak point developed by the American ships was their limited supply of ammunition, this especially having reached almost a critical stage during the battle at Manila.

This shortage of ammunition is partially attributed to the small ammunition-capacity of the earlier American vessels, but there is some reason to believe that it was also due to some extent to the fact that many projectiles had been expended in target practice, so that the superior precision of fire may have been attained at a cost which came néar being embarrassing.

The analysis of the various engagements contains no direct opinion concerning the true value of torpedo boats and destroyers, the writer rather being contented with an account of the attempts which were made to use these as yet somewhat experimental engines of naval warfare. The attack by day on Admiral Dewey's fleet, by two Spanish torpedo boats, during the battle of Manila, resulted in the destruction of both boats before they could get within torpedo range; the night attack on the Texas at Santiago failed from the premature discovery by the enemy, combined with incompetent handling of the Spanish boats; and the destruction of the Furor and the Pluton by the Gloucester may properly be attributed largely to lack of practical experience on the part of the crews of the formidable destroyers. What would have been the record of this class of craft had they been manned by Anglo-Saxons can only be conjectured, but it is safe to warrant that torpedo boats and destroyers will continue to be added to the navies of all first-class powers until some more decisive proof of their inferiority is forthcoming.

Submarine mines did not prove effective in a single instance, although many of them had been laid down by the Spanish in the harbours of Manila and Santiago. The controlled mines at Manila were exploded prematurely,—an evidence of such inexperience as is shown by the amateur photographer, who almost invariably makes an instantaneous exposure too soon, until he has learned to restrain his hand and use cool judgment instead of nervous excitement. The contact mines which were examined at Guantanamo were so clogged by marine incrustations as to be quite innocuous, and evidently much of the caution which was exercised in connection with submarine mines by the Americans was due to an over-estimate of the extent and character of these defenses.

The bombardments of Spanish fortifications by the American fleet did but little harm, except in the case of some of the older masonry structures, which were hardly expected to offer much resistance, and it was only in the destruction of some of the smaller forts along the coast that any really valuable work of this sort was done.

The analysis of the battle of Santiago, which practically terminated the war, is remarkably full and lucid. By using the reports of reliable press correspondents in connection with Admiral Sampson's official report, a continuous narrative is obtained, which is probably as near the true record as can be gathered from the numerous contradictory statements current immediately after the battle.

Without going into details, for which space is here lacking, the principal lessons to be gathered are the supreme importance of speed in battle-ships, the great desirability of powder which not only is smokeless, but produces no suffocating fumes, and the great danger from fire when much interior woodwork is used. The most effective work appeared to be that of the six- and eight-inch shells and the rapid-fire guns, and the manner in which the delicate range-finders and indicators were disabled by the shocks from the guns they were intended to serve should cause important modifications.

To quote the conclusion of the article: "It is plain that the Americans won by bravery, coolness, discipline, and drill. It is equally clear that the Spaniards were demoralised by the superiority of the Americans in rapidity and effectiveness of fire. The lesson seems to be that in future naval conflicts a superiority, however slight, in the beginning of an engagement becomes multiplied in its effect on an adversary by something like geometrical ratio, since the moral disorganisation produced by cutting off the return fire encourages accuracy of aim on the other side as fast as the ranges are found by actual trials. This, however, does not settle the question of whether many guns with light crews would be superior, other things being equal, to fewer guns with heavier crews, or with a competent reserve to take the place of men put out of action. Another most important deduction is that shooting in action with high-power guns by no means yet compares in accuracy with practice shooting."

It is interesting to note that in this excellent paper *The Engineer* definitely abandons its former attitude of favourable bias toward Spain, and takes a position, with practically all other publications of reputation, much more in accordance with the facts as now definitely ascertained.

The Designing and Construction of Refuse Destructors.

THE destruction of refuse by burning is now so fully accepted as desirable that the advisability of introducing suitable devices for the purpose is hardly longer a question. Rather is it important to consider the best form of destructor to be used, and it is this problem which is discussed in a paper read before the Dublin congress of the Royal Institute of Public Health by Mr. F. L. Watson, and published in *Engineering*.

In the first place, Mr. Watson emphasises the fact that complete destruction of refuse means an absolute chemical separation of the combustible portions (such as the carbon, phosphates, and nitrates, which are found in cinders and in animal and vegetable matter) from the non-combustible (which are chiefly mineral), and includes the complete oxidation of the former, and the fusion and agglomeration of the latter, so far as possible, into a hard clinker.

In order to accomplish these results, a high temperature, above all things, is necessary. This temperature should be not lower than 1,300° F., and had better attain

1,600° or even 1,800° F. In some forms of furnace the high temperature is reached only by the products of combustion in the flues, the gases coming off at a high heat; but the true principle of destruction requires that the heat should be great in the furnace itself, and should permeate the whole mass in the presence of sufficient air to oxidize everything oxidizable, ample time being allowed for the operation.

When this fundamental feature of high temperature in connection with proper supply of oxygen is accomplished, the resulting products are: a discharge of gases at a sufficiently high temperature to make them available for the generation of steam; a mass of hard clinker, or slag, which may be removed, crushed, and used with lime to form mortar; and a certain amount of dust, which should be removed in as cleanly a manner as possible.

When the temperature of the furnace is not as high as that indicated above, the destruction may be imperfect, and the resulting clinker, instead of being hard, is soft, friable, and frequently even putrescible; indeed, it is not uncommon for this imperfectly-burned clinker to take fire again after being removed.

The high temperature of the discharge gases renders them eminently adapted for the generation of steam, and in practice it is found that eight tons of refuse are about equal to one ton of coal for steam-raising purposes. In order to secure the best results, the boilers must be placed near enough to the combustion cells to prevent any important loss of heat by radiation, but they must not be placed near enough to interfere with the perfect combustion of the gases, which is generally not completed until after they have left the furnaces and traversed a certain length of flue to insure proper mixing. Even in the case of a boiler fired with coal any contact of the gases with the comparatively cool boiler surfaces will check the combustion and cause smoke, and it is obviously useless to mix oxygen with unburned gases after they have dropped below their temperature of combustion.

Since the principal expense incurred in the destruction of refuse is that for labour, it is an important matter to so design the furnace as to require a minimum of manual labour. This can be accomplished to a large degree in connection with the delivery of refuse and the charging of the cells, but so far mechanical stoking appliances have not given satisfaction, while they add greatly to the cost. Even in the case of an ordinary boiler furnace the exercise of considerable judgment is required to insure the best results, and with so variable a material as refuse it is necessary to use more care in cleaning than can be secured by any mechanical device.

The principal points to be borne in mind in the design of refuse destructors are: the production and maintenance of a high temperature in the furnaces; greatest facility for delivering and discharging the refuse at once into the cells; ample opportunity for the removal of clinker and dust; and, as an after consideration, a judiciously-arranged steam plant for the utilisation of the heat contained in the discharge gases.

Mr. Watson concludes his paper by the description of a number of existing plants, some of which have been remodeled from earlier forms, and others of which have been designed from the first in accordance with his views; and he gives much detailed information of value in connection with destructor-design.

Deliberate Train-Wrecking.

THE *Engineer* recounts four deliberate attempts at train-wrecking within a period of a few days and an area of fourteen miles. The first of them took place very shortly after the Wellingborough derailment (which, however, was not caused through malice prepense), and the four occurred, two near Northampton, one near Wellingborough, and the fourth at Oakley Junction, near Bedford. It is curious to note that the means employed in each case was an obstruction placed on or between the metals, instead of, as is common, a removal of some part of the track materials; in only two cases was any track material used.

In fact, in but one instance did the obstruction bear any evidence that it might have been put in position by a servant of the railway. This was at Wellingborough, and the attempt was made upon the same train which had suffered (by pure accident) the previous week. The arrangement consisted of two pairs of fish-plates, which were screwed together over each rail ; across these two heavy iron bars were laid, and a third bar was partly embedded in the ballast, with its upper end so inclined as to pierce the fire-box of a locomotive passing over it. In the opinion of the *Engineer*, the escape of the train was almost miraculous, and is to be accounted for only by the high speed and the consequent force of the impact.

This is undoubtedly the reason of the escape of the train, but such escapes occur more often than they are generally supposed to by any except the railway officers who conduct the investigations, and should not be regarded as remarkable. The total immunity of the four trains on which these apparently well-conceived attempts were made is a sufficiently clear proof of this statement.

In America, where no regular train locomotive (as distinguished from those used for shunting) is ever sent out unprovided with a pilot (cow-catcher), efforts so bungling would scarcely be expected to cause a wreck. The writer has a vivid recollection of a ride on a locomotive through the State of New York one wild and stormy night, where he sat on the same box with, and just behind, the driver. The line was built on the banks of a large river; the cuts, very badly drained at best, were generally through a blue clay mixed with boulders, and each heavy rain made these last come tumbling down with alarming profusion. In consequence, the train on this night was frequently stopped by the watching-patrol, to await the removal from the track of small avalanches of clay and rocks.

These delays made the train lose time, and the driver took advantage of a comparatively open stretch of country to pick up his speed. On a piece of straight line about fifty yards in front the head-light exposed a boulder quite half-a-yard in diameter, lying partly on the rail and partly on the sleeper. There was no time to stop, hardly time to appreciate the situation, but the driver gave his engine more steam, and yelled: "See me knock it!" And knock it we did, without further damage than a bruise on the pilot.

Another conclusion of the *Engineer*, which seems to lack the confirmation of experience, is that the motive of the crimes was train-robbery. In the light thrown by something like a score of investigations of deliberate attempts to wreck trains on a certain line, there were not more than two, or perhaps three (we speak from memory), in which robbery was finally regarded as even the possible motive. Like the four mentioned by the *Engineer*, they almost always occurred in batches, within a short period of time and a restricted area. Three attempts were once made within a week, in a space of a mile near a certain large town, all of which took the form of disconnecting the points and setting them in the wrong position for through trains.

Fortunately no wreck occurred, and the criminal, who was soon caught, proved to be a lad of fourteen years, the son of an old and reliable servant of the company, a plate-layer. The lad was bright and intelligent, but was apparently possessed of an uncontrollable tendency; and in his confession, which was complete and circumstantial, he stated that he had heard of wrecks, but had never seen one and wanted to. He was prosecuted, not for train-wrecking, but for pilfering (of which he was also guilty) and the public, were kept ignorant of the facts so far as possible, for experience had shown that, the more widely such things are commented upon, the more certain it is that other attempts will be made.

From the fact that no apparent effort at robbery was ever detected on any of the occasions when a train came to grief, it was finally concluded that some other motive must usually be assigned, even where it was impossible to reach a definite determination. But this was seldom the case, for in almost every instance, sooner or later, the facts became known. A farmer whose land bordered the line had a grudge against the company because of an unpaid claim. He therefore picked several stones from under the rail in the abutment of a small culvert, leaving one of the stringers practically unsupported. It was fortunately discovered in time to prevent what would otherwise have been a horrible destruction of human life, and it would have remained an unsolved mystery, if the scoundrel himself had not given the clue several months later, when in his cups.

On another occasion a discharged servant endeavored to balance accounts by removing some rail-fastenings, and in a well-remembered case an enemy had tried to injure a fellow-workman by dropping one of the latter's tools in the opening of a crossing point.

These and many other occurrences of a like character seems to demonstrate that most of the intentional wrecks are due to a degenerate mental condition, or to a criminal tendency on the part of those causing the wrecks, and that robbery is seldom the motive.

Wind Pressure.

THE address of Sir John Wolfe Barry before the Mechanical Science Section of the British Association, contains much matter of value, and among the numerous interesting subjects discussed we desire to note some points connected with the estimates of wind pressure upon framed and other structures. As long ago as 1840 Tredgold laid down the rule that provision should be made for possible wind pressures as high as 40 pounds per square foot, this figure having been obtained from measurements taken with a wind gauge. Following such an eminent authority, roofs and bridges, whenever any calculations for wind pressure were made, have generally been designed to resist a pressure of 40 pounds per square foot over the whole surface.

"Under the alarm caused by the fall of the Tay bridge in 1879, the piers of which were probably not strong enough to resist a horizontal pressure of one-fifth this amount, a further general assumption was made, and railway bridges throughout the kingdom were ordered by the Board of Trade in 1880, acting no doubt on expert advice, to be in future designed, and are designed to this day, to resist 56 pounds of horizontal wind pressure on the whole exposed area with the ordinary factors of safety for the materials employed, as if such horizontal strain were a working load."

It has been suspected, however, that tests upon small wind gauges do not give results which can properly be extended to large surfaces, and comparisons made at the Forth Bridge on two wind gauges of 300 square feet and 1½ square feet respectively, indicated that with an increase of area the unit of pressure fell off in a very marked degree. Under the same conditions of wind and exposure the larger gauge registered a pressure 38.7 per cent. less per square foot than the smaller gauge.

If this proportion holds good for all cases there has undoubtedly been a large excess of strength allowed in those modern structures in which the possible wind pressure of 56 pounds per square foot has been assumed as possible. Sir John himself states that experiments made at the Tower bridge have shown that the wind pressure on the bascules in certain instances, as measured by the power exerted by the actuating engines, was only 1 to 1½ pounds per square foot at a time when small anemometers registered 6 to 9 pounds, the area of the bascule under consideration being about 5000 square feet.

While it is very desirable that reliable data should be obtained for such an important element as wind pressure, it seems as if it would be unwise to accept a lower estimate than the existing one of 56 pounds per square foot until we are quite sure that the latter is too high.

Probably the best method we have at present for estimating the extreme force of wind pressure is that of the computation of the strength of structures which have been actually overthrown by it. At the time of the great tornado at St. Louis, in 1896, much damage was done by the wind, and in a paper subsequently presented before the American Society of

Civil Engineers Mr. J. Baier made some estimates which are of interest in this connection. In the case of some overturned bridge work he concluded that the lifting force of the wind could not have been less than 43 pounds per square foot, while in another instance the pressure on a surface 180 feet long by 18 feet high must have been at least 60 pounds per square foot. A chimney 162 feet high was broken in two at a point 40 feet from the ground, and taking the area upon which the wind acted as 14 by 110 feet this is estimated to have required a pressure of more than 80 pounds per square foot.

While such computations involve certain assumptions as to the resistance of the wrecked structures these are no more uncertain than the assumptions which must be made in the design of new structures, and while such tornadoes as that which occurred at St. Louis are rare yet their occurrence is within the bounds of possibility and should be provided for. It seems therefore hardly time to make any radical change in the estimate of wind pressure until some more certain information is available, although it is undoubtedly most desirable that all reliable data should be gathered and discussed.

Purification of Sewage by Bacteria.

Among the papers presented before the Bristol meeting of the British Association may be noticed that of Messrs. Dibdin and Thudichum upon the bacterial method of sewage purification. The work of Mr. Dibdin in this important field is so well-known that the latest expression of his opinions is of much interest, especially in view of the experience which has been had at Exeter, Sutton, and elsewhere.

This experience has shown that for the bacterial purification of sewage the following points must be considered: 1, Air supply or its absence in the case of the septic tank; 2, Temperature; 3, Admission or exclusion of light; 4, Reaction to test paper of the sewage to be purified; 5, Time of contact; 6, Nature of bed material; 7, Depth of bed.

"In the presence of a free air supply aerobic organisms are able to liquefy, break down, and oxidise solid organic matters without such decomposition being accompanied by any of the ordinary phenomena of putrefaction. Within two hours an effluent may be produced which may contain considerable quantities of nitric acid, and in which nitrification is afterwards continued at an extremely rapid rate."

For the aerobic process a free air supply is necessary, and an artificial air circulation may be employed, and even in the anaerobic process the air is not absolutely excluded from the septic tank, so that both processes really go on together.

In regard to temperature, it has been found that frost does not destroy the vitality of the organisms, the filter at Barking having continued to work although covered for six weeks with a sheet of ice.

The action progresses most favourably when the reaction to test paper shows a slight degree of alkalinity, but occasional variations in this respect appear to exert but little influence.

Time is a matter of importance, and it has been found necessary to subject the sewage to the action of microbes for a certain period, or the purification will be incomplete. If the proper time is greatly exceeded, however, the recuperation of the bed is affected. Two hours is found to be a satisfactory time for the sewage to be locked in the beds, the effluent being then allowed to escape, while the organic matter held in the bed is vigorously attacked by the organisms.

The bed may be made of coke, breeze, burnt ballast, broken slate, or the like, the depth being from 3 to 3½ feet.

In the general discussion of the bacterial processes of sewage purification there seems to be a general disposition to regard the subject with a certain degree of caution, the need of further definite practical information being undoubtedly felt. It is a question as to whether the anaerobic process is not always necessary as a precedent to the aerobic process, the formation of ammonia taking place first, during the two-hour resting period, and the nitrification following.

In connection with the proposed use of the processes on a large scale, the question of the varying character of the sewage must be taken into account, the changes in volume and composition, due to rain storms and other conditions rendering it impossible to insure uniformity. In order to determine the proper area to devote to a given quantity of sewage the London County Council proposes to institute a series of experiments on organisms for the purpose of finding out whether the methods which have given good results with small plants may be made available in dealing with 200 millions of gallons per day.

The Presidential Address of Sir Wm. Crookes.

THE meetings of the British Association always bring with them valuable and interesting papers on the branches of science dealt with by the various sections, but the especial feature of the recent meeting at Bristol was undoubtedly the presidential address of the incoming president, Sir William Crookes.

In this remarkable contribution to scientific thought and research so many subjects of fundamental importance were discussed that it is almost impossible to give even a meagre abstract of them, and naturally those dealing with the speaker's own special field of chemistry and physics were given especial prominence. In addition there were a number of topics of interest to the engineer which received attention, and the whole address forms a paper which should be read by all who are interested in modern scientific progress.

The main topic of the address, one which is only indirectly related to the work of the engineer, was the impending insufficiency of the wheat supply of the world. Natural resources being inadequate to meet the continual pressure of population upon subsistence, recourse must be had to the work of the chemist. "Before we are in the grip of actual dearth, the chemist will step in and postpone the day of famine to so distant a period that we, and our sons and grandsons, may legitimately live without undue solicitude for the future."

Passing on to matters in the domain of physics, the subject of radiography was taken up, and since it is due to the Crookes' tube that the work of Röntgen and his followers was possible, the subject could not have been in better hands. The principal feature brought out was the discovery that rays generated in "soft" tubes, or those having a moderate vacuum, have a less penetrating power than those emitted by "hard," or high-vacuum tubes. With a very high-vacuum tube Röntgen has photographed a double-barrelled rifle, showing not only the leaden balls within the steel barrels, but even the wads and the charges, while Dr. Rieder claims that the rays from "hard" tubes do kill bacteria, a question which, though often discussed, has not yet been positively settled.

The question of the property of certain substances of emitting rays similar to, if not identical with the Rontgen rays, without electrical excitation, was discussed by Sir William. Uranium and thorium compounds are of this character, and it may be that this is a general property of matter, since Dr. Russell has shown that nearly every substance is capable of affecting the photographic plate if exposed in darkness for a sufficient time. The investigations of M. and Mme. Curie have shown that there is a new constituent of pitchblende which possesses in a 400-fold degree the property of uranium of emitting a form of energy capable of impressing a photographic plate, without needing the excitation of light or the stimulus of electricity, apparently drawing from some exhaustless supply of energy. However much this idea may conflict with existing notions, there seems to be no doubt that there are many stores of energy in nature that may be drawn on by properly constituted bodies without very obvious cause.

Referring back to his own investigations into psychical phenomena, made many years ago, Sir William referred to the possible analogy between mental telepathy and space telegraphy, the action of the brain cells and nerves being marvellously like that of the particles in the Branly or Lodge coherer. However this may be, modern research seems to have brought the phenomena of mental and physical activity closer and closer together. Referring to the famous remark of his predecessor, Dr. Tyndall, in his Belfast address, that he "discerned in matter the promise and potency of all terrestrial life," Sir William said that he preferred to reverse the apothegm and see "in life the promise and potency of every form of matter"!

The Thermal Efficiency of Steam Engines.

THE importance of a standard of efficiency for steam engines such as to make the performances of engines tested at various times and places comparable, has been realised for some time, and in order to further the establishment of such a standard the Institution of Civil Engineers some time ago appointed a committee to investigate and report upon the subject.

With Prof. A. B. W. Kennedy as chairman and with such experts as Mr. Bryan Donkin, Prof. Ewing, Mr. Macfarlane Gray, Capt. H. R. Sankey, and others as members, unusual interest attaches to the report which is now made public, and while it consists only of recommendations, there is little doubt that in some modified form perhaps, the report will form the basis for a method of conducting engine tests which it is hoped will become an international standard.

"There are two methods of stating the thermal economical value of a steam engine. In the first, which is principally used for scientific purposes, it is expressed as a ratio, and it is in this connection that a so-called standard of thermal efficiency is needed; in the second and more ordinary method, an absolute statement is used, such as pounds of feed water per indicated horse-power, or heat units supplied per indicated horse-power per unit of time."

The term "thermal efficiency" has been applied to several different ratios, and it is desirable that any possibility of confusion on this account be prevented. The term has been applied to the ratio which the work done upon the piston bears to the heat supplied to the engine, and it has also been applied to the ratio of the performance of the engine to that of some ideal engine, or other less definite meanings have been given to it.

With the view of avoiding risk of misunderstanding in the future, and of obtaining the great advantage which would result from the adoption of a uniform system of nomenclature, the committee recommends the following definitions:—The expression "thermal efficiency" as applied to any heat engine should mean the ratio between the heat utilised by that engine and the heat supplied to it.

"In the case of any particular actual steam engine this ratio can be determined by calculations based on actual experiment in the following manner:—The heat units utilized as work are to be obtained by measuring the indicator diagrams of the engine in the usual way, to ascertain the mechanical work done. The heat supplied to the engine is to be calculated as the heat required to produce at constant pressure the steam that enters the engine, from water at the temperature of the engine exhaust. This rule applies whether the steam be saturated or superheated; also whether the engine be non-condensing or condensing."

When it is desired to compare the performance of an actual engine with that of some ideal engine the result is practically not an efficiency, but the ratio of two efficiencies, and for this reason the committee recommends that it be called the "efficiency ratio," thus avoiding a possible confusion of terms. For the ideal engine either the Rankine or the Carnot cycle may be employed, but the Rankine cycle is definitely recommended.

Incidentally attention is called in the report to the fact that the expression of the thermal economy of a steam engine in pounds of feed water per hour is inaccurate, since the number of heat units required to produce a pound of steam is not constant. With saturated steam the error is unimportant, but when superheating is employed the point becomes of consequence.

In order to facilitate comparison with an ideal engine on the Rankine cycle a diagram of curves showing the thermal units expended per minute per horse power is given, and entropy diagrams are also shown.

THE CONTINENTAL PRESS

The Briare Aqueduct and the French Canal System.

THE system of internal water-ways now existing in France provides for a very large traffic, which is constantly being increased by the improvements in canals and canalised rivers, one of the most recent pieces of engineering work in this line being the aqueduct over the Loire at Briare, a very full account of which is given in the *Annales des Ponts et Chaussées*, with numerous plates showing details, both of the aqueduct itself and of the lateral canal of the Loire of which it forms a part.

At the present time the waterways of France may be divided into four systems, which, with their approximate annual tonnage, are as follows:

Paris to Belgium, from 2,000,000 to 3,000,000 tons;

Paris to Havre, a minimum of 1,243,000 tons;

Paris eastward, by way of Reims, 600,000 to 800,000 tons;

Paris to Lyons, by way of the Bourbonnais, 400,000 to 600,000 tons on the canals of the Seine and Saone, and 565,000 tons by the lateral canal of the Loire.

The weak point of this last route has been the necessity of crossing the Loire at Chatillon-sur-Loire in order to make connection with the Briare canal on the right bank. This crossing involved locks on both sides of the river, the fluctuating level and especially the high floods causing much trouble and delay.

It was therefore decided to carry the canal across the river by means of an aqueduct, which necessarily involved a change in the canal level on both sides of the river, and practically a new construction of the canal for more than eight miles on the left bank, and a triple system of locks on the right bank. This reconstruction of the so-called lateral canal of the Loire was conducted before the aqueduct was built, the old canal and locks at Chatillon being used until the new water-way was opened.

The aqueduct over the Loire is of especial interest from the fact that, instead of being constructed of masonry, as is usually the case, only the piers are so made, the superstructure being made of mild steel and practically forming a steel tank nearly 2,000 feet long, 20 feet wide, and 12 feet deep. The main spans, of which there are fifteen, each 130 feet long, are really deep plate girders tied at frequent intervals by cross girders which also sustain the bottom of the tank, the webs of the main girders forming the sides of the tank.

The decision to make the superstructure of steel naturally involved the choice between the use of separate girders for each of the fifteen spans, or the construction of one continuous girder for the entire length of the aqueduct; taking into account the probable introduction of distorting stresses at each joint, in the case of separate girders, the continuous girder was chosen and built.

The selection of steel as the material was not determined upon until after some discussion of the relative merits of steel and iron for such use. Some apprehension was felt that steel was not sufficiently reliable to be used in a structure of such importance, and it was only after numerous tests that a mild steel was chosen. The material used gave, under test, a breaking strength of 60,000 pounds per square inch, an elastic limit of 31,000 pounds, and an elongation of 24 per cent.

In order to provide for the expansion and contraction of this long continuous girder, due to changes in atmospheric temperature, the aqueduct is rigidly secured only to the eighth, or central, pier, and is left free to expand in both directions from the centre. On all the other piers the supports are provided with roller bearings, to permit freedom of movement, as well as wedge adjustments, to allow the level to be restored in case of settling. A double water-tight packing is provided at each abutment pier, there being an inner U joint of rubber protected by sheet-iron plates, and an outer joint, packed with oakum, to check any leakage past the rubber.

The construction of the substructure of the viaduct offers no especially noteworthy features, except provision for the unusually large stationary load, due to the weight of the tank and its contents. The nature of the soil was ascertained by borings, a hard limestone being found at varying depths, to which caissons were sunk for the pier foundations, the dimensions of the pier being such that a maximum pressure upon any portion of the masonry does not exceed sixty pounds per square inch.

Many interesting details of this important work are given, for which the reader must be referred to the original memoir, which is very clear and complete, and should prove a valuable source of information in connection with future structures of this sort.

Hydraulic Cements in Sea-Water.

THE action of sea-water upon cements is a matter the importance of which must be conceded when it is remembered how extensive and important are the structures of masonry exposed to such action. An eminent Hungarian engineer, Herr Nádory Nándor, contributes a discussion of the subject to the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines*, and some of the points made are worthy of consideration and investigation.

Several years ago Dr. Wilhelm Michaelis announced, as the result of examination of many masonry structures immersed in sea-water, that Portland cement of the best quality does not resist the chemical action of sea-water so well as does the less expensive Roman cement, or as do the hydraulic limes under certain circumstances. According to the theory of Dr. Michaelis, the soluble sulphates—sulphate of magnesium, of calcium, and of sodium—enter into a substitution combination with the lime which exists in the cement in a free state or is liberated during the hardening. The free lime in this case is converted into sulphate, after which the silicate of lime and alumina is attacked. The mere formation of sulphate of lime causes an appreciable expansion of the mass, to the detriment of the strength of the cement. With the formation of gypsum occurs also the production of sulphate of lime and alumina, which causes a still greater expansion, amounting almost to a disintegration, owing to the large amount of water of crystallization, the result being that, grain by grain, the cement crumbles into a mud, leaving only those portions which are held together by the carbonate of calcium.

In the case of Roman cement all the lime exists in a state of combination, and there is no inclination towards the formation of sulphate. According to the observations of Dr. Michaelis, a good Roman cement resists the action of sea-water remarkably well.

Hydraulic lime, of which the best representative is the hydraulic lime of Teil, from the department of Ardêche, in the south of France, resembles Roman cement very closely in physical properties. When a mortar of this lime is exposed to the action of the air for a sufficient time before submersion, the outer portion of the free lime becomes converted into carbonate, which at ordinary temperatures does not subsequently form sulphate; and it is a well-known fact that concrete blocks made with this lime resist the action of sea-water very well indeed, an example being seen in the case of the breakwater at Boulogne.

As a result of his investigations Dr Michaelis recommends that hydraulic cementing materials containing more lime than is required for the formation of stable hydro-silicate and aluminate may be made suitable for submarine work by an admixture of trass, or puzzolana, thus not only greatly increasing the cementing strength of the mass, but also enabling it to withstand the disintegrating action of the salt water.

Of late there has also appeared a disposition to use granulated blast-furnace slag in connection with Portland cement, and tests made by Prof. Tetmaier at Zurich showed a marked increase in strength for additions of fifteen per cent. of ground slag.

In commenting upon these views of Dr. Michaelis, Herr Nándor calls attention to the importance of selecting a suitable cement for use with sea-water, and gives some interesting facts about the cement of Santorin, a variety of puzzolana found in the island of that name in the Grecian archipelago. At the time of the construction of the harbor works at Trieste a number of artificial blocks of concrete made with the hydraulic lime of Teil were used, and many of these showed insufficient resistance to blows and pressure. Later works being undertaken, it was decided to use the Santorin cement. The results were good.

The whole subject of the action of sea-water upon cement is one which has been too little investigated, and this paper of Herr Nándor is a timely one in calling attention to the theories and researches of such a high authority as Dr. Michaelis.

Power Gas for Tramways.

THE electric tramways at Lausanne, Switzerland, are of interest because the generators are driven by gas engines using a lean, or producer, gas; from an account of the plant given in *Le Génie Civil* some of the principal features are here given.

The high cost of coal in Switzerland renders economy in fuel a prime considertion in a power plant; so, when the question of motive power was under discussion at Lausanne, comparisons were made between the cost of steam and that of gas power. Several builders of steam engines were willing to guarantee an expenditure of not more than 22 pounds of steam per effective horse power per hour, which, with an evaporation of 8 pounds of water per pound of coal, corresponds to 2.48 pounds of coal per effective horse power per hour. At the same time offers were made by builders of gas-power plant to instal an apparatus which should require not more than 1.137 pounds of coal per horse power, the fuel being consumed in a producer and the gas used in gas engines.

The latter method was adopted, the builders being held under strong contract to fulfil the guarantee; and, as the plant has now been in operation for two years, definite data as to its working may be obtained.

The plant consists of three Crossley gas engines of 130 h. p. each, and three gas generators of the Taylor revolving-bottom type. The gas is generated by delivering a blast of superheated steam and air through a bed of incandescent fuel, the steam being somewhat in excess of the quantity necessary to produce the blast, the gas thus being partly a water-gas and partly a producer gas, and having a higher calorific power than that of ordinary producer-gas. The gas is passed through condensers, scrubbers, and purifiers, and is then delivered to a holder, from which it is drawn to the engines.

According to the experience of the past two years there has been no difficulty with clinker, the cinder being removed by revolving the beds in the generators once a day.

The gas engines are of the double-cylinder type, the cylinders being opposed to each other on the same axis, thus giving an impulse to the crank every revolution. This, combined with the use of a six-ton fly-wheel, gives a steadiness of motion which is found satisfactory in practice. Owing to the cost of water at Lausanne, the cooling water in the cylinder jackets is not allowed to run to waste, but is delivered into a cement-lined tank, where it is cooled by spraying and used again and again.

Each engine is connected directly to an electric generator of the Thury type, the speed being 160 revolutions per minute, and a battery of 300 accumulator elements, with a capacity of 700 ampere-hours, is used to assist in equalizing the load.

The length of the road is a little over eight miles, of which less than a quarter of a mile is on a level. In fact, the Lausanne tramway possesses, it is claimed, more grades and more curves of short radius than any road in Europe, the maximum grade of 11.3 per cent. being one of the steepest in Europe operated by adhesion alone.

There are twenty-five tram cars, each for thirty-two passengers, and each being provided with two Thury motors of 20 h. p., the current being supplied by sliding overhead trolley. Each car is furnished with an independent electric brake, in addition to the ordinary friction brake, thus providing for possible derangements of either, which might become serious on steep grades.

During the first half of 1898 the total consumption of coal in the entire establishment was 850,000 pounds, and the corresponding output of power was 413,849 kilowatts, or 2.05 pounds of coal per kilowatt. These figures are of more practical value than those which might be obtained from a scientific test, since the coal consumed represents not only that burned during working hours, but also that used at night and at other times, as well as that burned under the boiler which furnishes the distilled water for the accumulators.

With steam engines of the same size, requiring 2.48 pounds of coal per h. p. the corresponding expenditure would be 3.78 pounds per kilowatt; thus an economy of more than 20,000 francs per year is effected by the use of gas-power instead of steam, disregarding the cost of condensing water in the case of the steam power.

It is from such installations that the practical information must be obtained which will lead to the construction of gas engines of large size. With experience in the use of power-gas for general motive power much of the present waste of fuel will be avoided.

The Zeiss Telemeter.

It has always been deemed desirable that some method should be devised for ascertaining the distance of a visible object without being obliged to resort to the laborious, and in many cases difficult, operation of actual measurement. When the object can be observed from the extremities of a known base-line, the problem is a simple one, but, where only one point of view is possible, it is not so easy. The use of stadia hairs in a telescope involves the presence of a graduated staff at the point observed, and, however advisable in surveying, is therefore out of the question for military purposes; and for isolated observations of unknown objects, seen from a single point of view, the problem has not as yet been solved to the entire satisfaction of either theoretical or practical men.

A new form of telemeter, designed by Zeiss, the famous optician of Jena, is described in a recent issue of *La Revue Technique*, and, as it possesses some points of novelty and has given good results in practice, it may be accepted as at least an advance towards the solution of the problem. The fundamental principle involved is that of the ordinary stereoscope, or rather the stereoscopic effect which appears in natural vision, due to the difference of angle at which an object is seen by the two eyes. As a matter of fact, it is really due to the distance between the eyes that we are able to estimate distances with the unaided vision, and for objects which are within the range of the visual appreciation of this difference of angle it is possible so to train the faculty as to enable fairly accurate estimates to be made.

The small distance between the eyes, however, as well as the limited range of vision, makes the ordinary estimate not much better than a guess, and the Zeiss telemeter aims not only to widen the base-distance and multiply the distance of distinct vision, but also to add a scale from which the distance of the object seen may be found within pre-determined limits of precision.

The increase of base distance, or practical separation of the space between the eyes, had already been accomplished in the so-called telestereoscope of Helmholtz, in which four mirrors were used to multiply the distance about ten times. This device was little more than an optical toy, and was simply used to produce exaggerated stereoscopic effects. Zeiss uses the same principle, employing prisms instead of mirrors, and also adds a double system of lenses, giving a magnifying power as well as a widened base of binoclar vision. If this system were so adjusted as to give perfect stereoscopic effect, the two images formed by the two branches would be superposed, and the result would be a single image of greatly-exaggerated relief. It is possible, however, so to arrange the relation that each object is seen in double, and that the distance between the two images of any object in the field of view varies in proportion to the distance from the observer. By the introduction of graduated scales in the eye-pieces, the distance by which the images of the object in view are separated may be measured, or, more conveniently, the scale may be so graduated as to permit the distance to be read off directly.

For moderate distance—within 3,000 metres—this direct arrangement of scale is fairly satisfactory, and this form has been made for use in the Austrian infantry as an artillery range-finder. For greater distances, and when more precise readings are desired, a micrometer with movable hair is applied, a fine screw being turned until the hair has moved from one image of the object to the second image of the same object, the reading being subsequently taken from the graduated head of the micrometer screw.

Tests made with these instruments show that for a distance of 1,500 meters an error of 0.35 per cent. was made, while for 3,000 meters the error was 0.70 per cent., and for 6,000 meters 1.40 per cent.

The Influence of Moisture in Spinning.

It has long been known that the condition of the atmosphere exercises an important influence upon the quality and uniformity of yarn, and the superiority of the product of certain localities has frequently been attributed to the weather.

A paper read upon this subject at Hanover by Herr Joh. Körting, and published in the *Zeitschr. des Vereines Deutscher Ingenieure*, examines the advantages claimed for a moist atmosphere, giving photographic enlargements of threads spun under different conditions of moisture, and describing various appliances for producing artificially the degree of humidity which gives the best practical results.

After discussing the conditions of atmospheric humidity, and explaining briefly the meaning of relative humidity, as a percentage of complete saturation, showing also the greatly-increased amount of moisture required to produce a given humidity at high temperatures as compared with lower ones, the author discusses the best conditions for various kinds of work.

The English authority, Dobson, states that a relative humidity of 50 per cent. is correct for cotton spinning, but the experience of the mills at Mulhouse, in Alsace, points to a higher degree of humidity as desirable, from 65 to 75 per cent. being usual for spinning and 60 per cent. for weaving.

When the proper degree of humidity is maintained, the result is a smooth, high-grade yarn, and a greatly-diminished loss by breakage of threads, the output being increased 6 to 10 per cent.

An examination of micro-photographs of threads produced under different conditions of humidity shows a marked difference as to smoothness, those spun in a dry atmosphere being fuzzy, with many loose fibres standing out from the main strand. One of the explanations of the action of the atmosphere is that in dry air the fibres become electrified, and thus repel each other, while a moist atmosphere is not so readily charged with electricity.

Assuming that the condition of the atmosphere is the true cause for the difference in the quality of yarn produced in different localities, there should be no great difficulties in producing artificially the proper degree of humidity, and in practice two methods have been employed for the purpose. In one case the air is charged with moisture in a chamber separated from the spinning room, and then delivered in the course of ventilation, while, in the other method, the moistening apparatus is placed directly in the work-room.

The first method involves some mechanical system of ventilation, in order that the delivery of moist air may be controlled; a pressure blower of some sort is usually employed. The air delivered from the blower is sometimes passed through a tower filled with lumps of coke upon which water trickles; in other cases the water is sprayed by atomizers directly into the current of air as it passes from the fan. This method, to be satisfactory, must be accompanied by a very complete system of distributing passages, so that the moistened air may be delivered uniformly to all parts of the work-room: otherwise the inequality in the humidity will be apparent in the different parts of the room. As shown by Herr Körting, the distributing flues are placed under the floor, and openings provided so as to give as nearly as possible a uniform atmosphere about all the machines, while an exhaust ventilator maintains a proper circulation.

When the moistening is done directly in the work-room, various forms of apparatus may be used. Formerly open troughs of water were employed, the air being caused to pass over the surface of the water, which was warmed by a steam coil to increase the rapidity of its evaporation; but this method has not proved very satisfactory in practice.

During the past fifteen years various forms of atomizers and moisteners, under such names as "aerophores" and "drosophores," have been introduced, these consisting of devices for spraying water into the incoming air and at the same time deflecting the current upward and about in such a manner as to mix the water with the air so thoroughly as to insure its complete absorption. By placing these devices about the room, suspended from the ceiling, the air, with certain precautions, may be given such a degree of humidity as will largely make up for any deficiency.

Owing to the great variation in the capacity of air to absorb moisture at various temperatures, and to the fact that it is a constant relative, and not absolute, humidity which it is desirable to maintain, no system of moistening is complete which does not take into account the temperature of the room. A slight change in temperature may cause the relative humidity to vary to an extent sufficient to produce a marked effect on the product; this point is especially difficult to manage in warm weather, when artificial warming apparatus is out of use. During winter the relative temperature and quantity of water sprayed may be fairly well controlled, and in all cases reliable hygrometers should be placed in various parts of the room, so that changes in the humidity may be observed and corrected.

The whole subject is one which, in the present state of meteorological science, should be capable of very precise investigation, and the application of such knowledge, with modern mechanical ingenuity, should render it possible to produce and maintain any desired constant state of atmosphere more readily than heretofore.

Normal Building-Sand.

AN important feature in connection with the use of mortars and cements in masonry structures is the nature of the sand used in the mixture; yet in nearly all tests the cement is the main object under consideration, the sand being often rather neglected. It is this fact which gives especial interest and value to the tests, of so-called normal sands selected from various countries, recently conducted by Herr M. Gary at the Berlin Testing Laboratory. From the *Mitt. aus den Kgl. Technischen Versuchsanstalten*, in which the full report appeared, the following abstract of the work is given. It is well that attention has been directed to so fundamental an element in building construction.

Ten different varieties of sand were tested, and, in order that there might be no doubt as to the high quality and character of the samples, care was taken to have them selected by experts of acknowledged reputation in the various countries from which they were obtained.

Two varieties from Germany were tested, one being a crushed quartz from Freienwalde in Prussia, and the other the sand obtained from the Rhine by dredging. Single samples of standard sand were obtained from Austria, Switzerland, Russia, Norway, England, and the United States, and two samples from France, one of these being from Leucate, a natural sand brought down by the mountain streams of the

Pyrenees, and the other a crushed quartz from Cherbourg.

The tests of the ten varieties of sand consisted in a chemical analysis, and a measurement of the loss of weight at red heat, as well as a determination of specific gravity, and size of grains, after which briquettes were made with Portland cement and subjected to tension tests after seven, twenty-eight, and ninety days' hardening under water. Two sets of briquettes were made with each kind of sand, one set containing one part by weight of cement to three of sand, and the other one part of cement to five of sand. The former proportion represents the usual practice in nearly all countries; the latter was used to the extent to which the addition of a greater proportion of sand affects the strength. Very interesting microphotographs were made of the samples of sand, and the difference in the character of the grains was in some cases very marked.

It is impossible to go into the details of these interesting tests, which are fully tabulated and illustrated with diagrams in the original report, but some of the conclusions are here given.

Among other points it was found that the very sharp crushed quartz sand, which under the microscope showed an angular structure, gave a high tension test and a low compression test, while the natural sands, with rather rounded grains, gave proportionally better results in compression. Thus for the American sand, a crushed quartz from Massachusetts, the ratio between the tension and compression tests was 1:5.7, while for the English sand, which, under the microscope showed round smooth grains, the ratio was 1:10.

The resistance to tension for the mixture of three of sand to one of cement was, for the English and American sands, respectively 424 pounds and 451 pounds per square inch, while for compression the figures were 4,300 pounds and 2,560 pounds. The American sand stood among the highest in the tension tests, being equalled only by that from Switzerland, but in the compression tests it was much lower than any other, the next higher being 3,500 pounds per square inch. On the other hand, the only sand which equalled the English sample in compression was that dredged from the Rhine, which also showed a similar rounded granular constitution. This feature is one which is worthy of further investigation, as, if it is possible to obtain high tension tests for a cement by the use of a sharp sand, while at the same time its resistance, when applied in practice with similar sand under compression, is diminished, these facts should be taken into consideration, or else, more properly, both tension and compression tests should be required.

Tests made with mixtures of sands of coarse and fine grains showed inferior results to those obtained with sands uniform in size of grain.

In concluding his report, Herr Gary recognizes the fact that the tests, being made with but one kind of cement and with a limited number of samples of sand, can be considered as giving only general indications of the behavior of the materials. Many additional tests must be made before positive conclusions can be drawn. The results, however, certainly emphasize the importance of taking into account the nature of the sand in connection with tests and uses of mortars and cements, and, if such tests are continued, they may lead to the establishment of an international standard.

Electric Power in Mining.

THE general value of electrical transmission in connection with mining work is now generally understood, and numerous installations have been made. Among the more recent plants for coal mining by electric power one of especial interest is found in the Ziegler mine at Nürscham, of which a very full account is given in successive issues of the *Oesterr. Zeitschr. für Berg und Hüttenwesen.*

In this particular case the shaft had been deepened and the main seams of coal exhausted several years ago, but, certain lower seams having been discovered which offered especial difficulties in working, it was decided to introduce electric power for the exploitation of this new portion of the mine.

The principal features to be contended

with in the installation were the dampness, due to the constant and rapid accumulation of water in the workings, and the thinness of the seams, which greatly limited the working space in some cases.

The electric power is chiefly used for hauling and for pumping, the hauling being performed by chain and cable traction systems with electrically-driven winches; the current is used also for driving blowers, and for lighting.

Notwithstanding the dampness of the workings, it was decided to use uninsulated wires for the greater portion of the distribution, although there is a tension of 500 volts. The main conductor down the ventilating shaft is protected by a cotton wrapping with an additional covering of tarred tape, and a similar protection is used in some of the untimbered parts of the mine, but in most of the system the wire is uncovered, porcelain insulators filled with paraffin being depended upon to secure insulation.

The pumping machinery is varied in character, there being a triple-cylinder stationary pump of a capacity of 3,000 litres per minute, a double centrifugal portable pump, mounted on a car, and a shaft pump of the rotary type, operated by its own motor, and arranged to be slung by chains in the shaft during the work of sinking.

There are several haulage systems employed, the principal one being on the incline connecting the new workings with the original mine, while separate winches are used for the various portions of the new workings, both for hauling on slopes and in shafts.

Most of the motors are of one style and size, thus simplifying the matter of repairs, connections, etc., in the electrical work. Belt connections are made to the machinery and timber framing, with marble and porcelain insulation, is used under the motors.

Although electric cutting machinery is not used in this plant, probably owing to the thin and broken character of the seams,—the use of electric power for all other work in connection with the development of the mine appears to have been the one thing which made the working of this portion possible, and the success of the plant demonstrates that, in cases where the older methods may prove too expensive to permit the profitable winning of poor seams, the use of electric power will sometimes enable the work to be accomplished to advantage.

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Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienn
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Beams.

The Design of Compound Beams. An editorial discussion, with especial reference to the investigations of Prof. Kidwell. 1000 w. Eng Rec—Sept. 10, 1898. No. 22732.

Cathedrals.

The Cathedrals of England. S. Parkes Cadman. A careful survey of these cathedrals with illustrations. 3000 w. Chau—Oct., 1898. No. 22841 C.

Church Architecture.

All Saints, Wittering. C. Lyman. Illustrated description of the peculiar Saxon chancel of this Northamptonshire church. 800 w. Builder—Sept. 3, 1898. No. 22656 A.

Cupola.

Construction of a Cupola on a Hospital. W. Neubecker. Illustrated description of the erection of a piece of ornamental metal work. 500 w. Met Work—Sept 10, 1898. No. 22611.

Goodrich House.

The Goodrich House, Cleveland, O. Illustrated description of a carefully planned building for social settlement work. 1000 w. Eng Rec—Sept. 24, 1898. No. 22895.

India.

The Mogul Architecture of Fathpur Sîkrî. Deals with the historical relations, characteristic forms, and structural and decorative details. 3000 w. Ill. Builder—Sept. 10, 1898. No. 22659 A.

Ironwork.

Notes on the Design and Erection of Architectural Ironwork. Henry A. Cutter. A paper read before the Royal Institute of Public Health. Reviews the development under the influence of costly sites, concentrating population, and demands for light, air, and fire protection. Considers structural shapes and formulates principles of design and erection. 2500 w. Ill. Builder—Sept. 3, 1898. No. 22660 A.

Japan.

The Early Architecture of Japan. Ralph Adams Cram. A historical and critical review. 3000 w. Ill. Arch Rev—Sept., 1898. No. 22663 G.

Masonry.

Masonry. Discusses the nature and properties of the stones employed, the various ways in which they are combined in building construction, and the importance of sound jointing. Ill Car & Build—Aug. 26, 1898. No. 22582 A.

Pueblo Masonry. Cosmos Mindeloff. Describes the characteristics of this masonry. 1500 w. Ill Car & Build—Aug. 26, 1898. No. 22581 A.

Peterborough Cathedral.

Peterborough Cathedral; West Front. Rev. T. Garbett. A historical and architectural commentary. 2200 w. Ill. Arch, Lond—Sept. 2, 1898. No. 22646 A.

Staircase.

The Statics of Overhanging Steps in the Staircase Experiments. (Die Statischen Verhältnisse der Freitragenden Stiegenarme bei den Versuchen des Stufenausschusses.) J. E. Brik. A mathematical discussion of the statical equilibrium of the members of the experimental staircases tested by the Austrian Society of Engineers. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 19, 1898. No. 22911 B.

Steel Construction.

Probable Increase of Steel Construction. Showing the advantages in fire protection, reduction in cost and improvement in materials which make probable the adoption of steel in residence building. 2000 w. Arch & Build—Sept. 17, 1898. No. 22673.

Theatre.

The New Royal Theatre at Wiesbaden. (Das Neue Königliche Theater in Wiesbaden.) With views of the exterior and interior, and plans and sections of the building. The mechanical details are of much interest, and the general design noteworthy, the orchestra being sunk below the parquet, as at Bayreuth. Two articles. 4000 w. Deutsche Bauzeitung—Aug. 13, 17, 1898. No. 22962 each B.

Workmen's Houses.

Working-Class Dwellings in Dublin. Extracts from an address by Sir Charles A. Cameron. Reviews progress in 30 years, influence on sanitation, comfort and morality and municipal bearings of the movement. 1700 w. Arch, Lond—Aug. 26, 1898. No. 22644 A.

HEATING AND VENTILATION.

Auditorium.

Ventilation of Steinert Hall, Boston. A full account of the method of heating an auditorium and music hall in Boston, by means of which the purity of the atmosphere is maintained at all times. 2000 w. Eng Rec—Sept. 17, 1898. No. 22746.

Boilers.

The Condition of Schoolhouse Boilers. Editorial based upon the report of a Massachusetts District Police Inspector, discussing the manner in which boilers in school houses are neglected, and the consequent risk of explosion. 800 w. Eng Rec—Sept. 17, 1898. No. 22740.

Columbia University.

The Heating and Ventilating of Columbia University. G. A. Suter. An explanation of the theory of the heating and ventilating apparatus, describing the details necessary to a proper understanding of the subject. 6000 w. Sch of Mines Quar—July, 1898. No. 22428 D.

Furnace Heating.

A Departure in Furnace Heating. Illustrated description of a system employing round pipes of unusually large area throughout. 1600 w. Met Work—Sept. 10, 1898. No. 22612.

Government Building.

Heating of a Norfolk, Va., Government Building. Describes and illustrates the hot-water system recently installed. 1000 w. Eng Rec—Sept. 24, 1898. No. 22896.

Steam Pipes.

The Computation of the Loss of Pressure in Steam Pipes. (Die Berechnung der Druckverluste in Dampfleitungen.) J. B. Goebel. A mathematical discussion, deriving fundamental equations, and showing their practical application to high and low pressure steam; with sheet of tables for practical use. Two articles. 1 plate. 4500 w. Gesundheits Ingenieur—July 15, 31, 1898. No. 22921 each B.

Ventilating Plant.

Ventilating and Heating of the Singer Building, New York City. Illustrated description of a plant which supplies fresh air to every room of a ten-story building. The direct-indirect system is employed. 2000 w. Eng Rec—Sept. 3, 1898. No. 22537.

PLUMBING AND GASFITTING.

Bathtubs.

The Development of the Bath-tub in New York. A reprinted article discussing the increasing demand for bath-tubs in even the cheapest tenements, the kinds of tubs most used, bathroom accessories, &c. 1000 w. San Plumb—Sept. 1, 1898. No. 22539.

MISCELLANY.

Argentina.

Building in the Argentine Republic. A review of the local peculiarities of design, materials, and construction, legal requirements, and customs as to building contracts. 2800 w. Builder—Sept. 3, 1898. No. 22655 A.

Chimney.

See Mechanical Engineering, Miscellany.

Cowdray House.

Cowdray House and its Owners. J. L. André. Read at the annual excursion of the Horsham Museum Society. Historical review of the ancestral home of the Montague family. 2000 w. Arch, Lond—Sept. 2, 1898. No. 22647 A.

Enameled Brick.

Making Enameled Brick. A brief statement of the methods of working, moulding, dipping, and burning. 1000 w. Brick—Sept., 1898. No. 22607.

Garden.

The New Horticultural Garden of the City of Paris. (Le Nouveau Jardin Fleuriste de la Ville de Paris.) M. Seurat. A general view of the grounds at Auteuil, with details of the structural work of the conservatory buildings and of the heating apparatus. 2500 w. 1 plate. Le Génie Civil—Aug. 13, 1898. No. 22927 D.

Garnier.

Notes upon the Architectural Work of Charles Garnier. J. R. Coolidge, Jr. A study of his designs for large theatres. 2500 w. Ill. Arch Rev—Sept., 1898. Serial. 1st part. No. 22662 G.

Headquarters.

The Octagon House. Brief illustrated description and historical sketch of the house leased in Washington, D. C., for the national headquarters of the Am. Inst. of Archts. 1200 w. Arch & Build—Sept. 3, 1898. No. 22547.

Inscriptions.

On Architectural Inscriptions and Insignia. An argument for the use of appropriate heraldic or literary designations and for the architect's signature, with comment upon some offenses against good taste. 1300 w. Builder—Sept. 3, 1898. No. 22657 A.

Interior Decoration.

Grounds of Walls and Paintings. A discussion of the difficulties of determining a color scheme, the methods of great masters, and the psychological effect. 2200 w. Arch, Lond—Aug. 26, 1898. No. 22643 A.

Lich-Gates.

Lich-Gates. John S. Holbrook. Illustrates and describes these structures, peculiar to England, which are built at the entrance to churchyards so as to form a shelter under which the bier or coffin may rest. 1000 w. Am Arch—Sept. 24, 1898. No. 23044.

Mexico.

Mitla and Other Ancient Cities of Mexico. L. Viajreo. Account of the archæological studies of W. H. Holmes, as drawn from his report, with special reference to architectural features. 1800 w. Ill. Am Arch—Sept. 10, 1898. No. 22675.

Mortar.

The Chemical Examination of Mortar. H. F. Hills. Reports the examination of various samples of old mortar. 800 w. Builder—Sept. 17, 1898. No. 23001 A.

Sand.

Normal Sand. (Normal-Sande.) M. Gary. A report upon the results of the tests at the Berlin Royal Testing Laboratory upon various kinds of building sand, with reproductions of microphotographs of sand from a number of localities. 7500 w. 2 plates. Mitt aus den Kgl Tech Versuchsanstalt—Part 3, 1898. No. 22952 G.

Stone.

Machine vs. Hand-cut Stone. Henry Gorse. On the evils due to the use of machinery, and urging that it be abolished on all buildings whose adornment and durability is a matter of importance. 1800 w. Stone—Sept., 1898. No. 23036 C.

Wind Pressure.

Wind Pressure on Exposed Structures. From the inaugural address of J. Wolfe Barry, before the Mech. Science Sec. of the British Assn. The unnecessary anxiety from hasty generalizations on this subject. 800 w. Jour of Gas Lgt—Sept. 13, 1898. No. 22848 A.

Woodcarving.

Examples of French Woodcarving. Notice of a portfolio of photographic reproductions of French woodcarving in our national museums, edited by Eleanor Rowe. Ill. 2800 w. Builder—Sept. 17, 1898. No. 23000 A.

CIVIL ENGINEERING.

BRIDGES.

Beton.

The Kaiser Bridge at Sarajevo. (Die Kaiserbrücke in Sarajevo.) Josef Schustler. Description and photograph of a combined steel and concrete arch of 83 feet span over the Miljacka river, at Sarajevo, Bosnia. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 9, 1898. No. 22916 B.

Bridge Building.

Bridge Building, Past and Present. (Der Brückenbau, Sonst und Jetzt.) Prof. Mehrtens. A very interesting address delivered before the Technical Society of Frankfurt am Main, with many illustrations of famous bridges. Two papers. 4000 w. Schweizerische Bauzeitung—Sept. 3, 10, 1898. No. 22986 each B.

Combination Truss.

Combination Bridges. A. D. Otteweil. A discussion of the advantages of using iron, steel, and wood, in combination, for bridge trusses, with illustrations and details of several such structures. 1200 w. Engng—Sept. 9, 1898. No. 22716 A.

Disaster.

Bridge Disaster at Cornwall, Ont. With photographs showing the condition of the work at and after the time of the fall of the pier. 1800 w. Eng News—Sept. 15, 1898. No. 22730.

The Bridge Failure at Cornwall, Ont. An account of the failure of this nearly completed bridge, giving such information as is at present available, together with illustrations showing the condition of the structure immediately before and after the failure. 1200 w. Eng Rec—Sept. 17, 1898. No. 22744.

Erection.

Erection of the Albert Bridge by Launching. Describes the interesting features and the methods used in the erection of this railway structure across the river Brisbane, in Queensland, Australia. 1800 w. Eng Rec—Sept. 24, 1898. No. 22890.

Erection of the Lake Street Arch Bridge, Minneapolis. Illustrated description of the erection of a bridge 1,271 feet long, and 120 feet above the bed of a shallow part of the upper Mississippi River. 900 w. Eng Rec—Sept. 24, 1898. No. 22889.

Floating Bridge.

An Old Floating Bridge. C. J. H. Woodbury. Read before the Essex Inst., Mass. Describes a floating bridge at Lynn on the Salem and Boston turnpike, nearly a century old and still in use. 2700 w. Engng—Aug. 26, 1898. No. 22572 A.

Foundations.

Historical Discussion of Pneumatic Foundations. (Beitrag zur Geschichte der Druckluftgründung.) A. Schmall v. Eisenwerth. An account of the early applications of the pneumatic methods of sinking foundations for bridge piers with especial reference to the construction of the railway bridge over the Rhine at Kehl, 1859. Two articles, 10,000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 2, 9, 1898. No. 22915 each B.

Highway Bridge.

The Davis Avenue Cantilever Highway Bridge, Allegheny City, Pa. Illustrates the strain sheet and some of the more important details of a cantilever highway bridge now being built to span a deep ravine. 700 w. Eng News—Sept. 1, 1898. No. 22461.

Joint.

Experiments upon a Flexible Joint for Riveted Structures. (Expériences sur un Joint Flexible pour Charpentes Metalliques Rivées.) M. Mesnager. The advantages of providing flexibility in certain members of a riveted framework are shown by tests. The recommended forms of construction are illustrated. 2500 w. 2 plates. Ann des Ponts et Chaussées—2 Trimestre, 1898. No. 22951 F+G.

Park Bridges.

Park Bridges. Oscar Sanne. Illustrated description of designs erected in the Milwaukee Lake Park, the aim being to fulfill the engineering requirements and also make the structures of high artistic value. Discussion. 4000 w. Jour of W Soc of Engs—Aug., 1898. No. 22796 D.

Railway Bridge.

Double-Track Steel-Arch Railway Bridge, Muengsten, Germany. Abstract of article by A. Rieppel, in *Zeitschrift des Vereines Deutscher Ingenieure*. Information relating to the design and erection of the bridge, with illustrations of the principal features. 1400 w. Eng News—Sept. 1, 1898. No. 22464.

Replacement.

The Victoria Jubilee Bridge. A brief but clear account of the method of replacing the tubular bridge by a new double-track truss bridge without suspending traffic. 1300 w. Ill. Can Engr—Sept., 1898. No. 22699.

Suspension.

The Covington and Cincinnati Suspension Bridge. A description of the reconstructed bridge, with details of the towers, anchorages and truss work. Serial. Part 1. 2500 w. Eng Rec—Sept. 10, 1898. No. 22736.

Swing Bridge.

Turning Machinery for the Rock Island Bridge Swing Span. Illustrated description of the turning machinery of a bridge across the Mississippi. 3600 w. Engng—Sept. 16, 1898. No. 22876 A.

CANALS, RIVERS AND HARBORS.

Antwerp.

The Port of Antwerp. (Le Port d'Anvers.) A. Dumas. With map and plan of the city, and numerous illustrations of the quays, docks, and landing stage. An account of the new quay wall, now in course of construction is also given. 3000 w. 1 plate. Le Génie Civil—Aug. 20, 1898. No. 22928 D.

Aqueduct.

The Briare Canal Aqueduct. (Pont-Canal de Briare.) M. Mazoyer. A very complete account of the construction of this great canal aqueduct over the Loire, also including smaller aqueducts along the line of the Loire canal. 30,000 w. 9 plates. Ann des Ponts et Chausées—2 Trimestre, 1898. No. 22948 F + G.

Canal Lift.

The Henrichenburg Canal Lift. (Das Schiffshebewerk bei Henrichenburg.) An account of the completion of the work. The weight of the tank and water is counterbalanced by the buoyancy of pontoon tanks, and the raising and lowering effected by screws. Boats of 600 tons displacement are raised 50 feet at one lift. 2500 w. Stahl und Eisen—Sept. 1, 1898. No. 22955 D.

Dams.

Difficulties with Earth Dams in Great Britain. Illustrated description of three dams which were built after unusual plans. 4000 w. Eng Rec—Sept. 3, 1898. No. 22534.

The Computation of Masonry Dams for Reservoirs. (Calcul des Barrages de Réservoirs en Maçonnerie.) M. Barbet. Discussing and extending the recent treatment by M. Maurice Lévy, based upon the elastic theory. 8000 w. Ann des Ponts et Chaussées—2 Trimestre, 1898. No. 22950 F + G.

Docks.

Dock Extensions at Liverpool. Reviews the improvements of the last three decades, specially describing the changes now in progress. Ill. 6500 w. Engr, Lond—Aug. 26, 1898. No. 22573 A.

New Dock at Grangemouth. General description of a new enterprise of the Caledonian railway, the extent of the work and the methods to be employed in carrying it out. It will be a concrete structure, and the earthwork to be disposed of from 3,000,000 to 4,000,000 cu. yds. 1000 w, Arch, Lond—Sept. 2, 1898. No. 22650 A.

The Algiers Dry Dock. A description of the proposed dry dock to be built at Algiers, La., with specifications for material and workmanship. 1200 w. R R Gaz—Sept. 2, 1898. No. 22523.

The New Graving Dock at Glasgow. Giving the detailed specifications for this important structure with plan, and section, also plate of details of caisson gates, and illustration of hydraulic caisson hauling engine. 3500 w. 1 plate. Engng—Sept. 2, 1898. No. 22711 A.

The Stettin Floating Graving Dock. Reprinted from the *Engineers' Gazette*. Gives briefly the history of floating docks, and describes the noteworthy features of the dock named. Ill. 3000 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22449 H.

Dredges.

Hydraulic Dredges. Statements from a paper by Lindon W. Bates, on high-power dredges and their relation to sea and inland navigation, presented at the International Congress of Navigation, at Brussels. 2800 w. Eng Rec—Sept. 24, 1898. No. 22891.

Sand-Pumping Dredger "Alexander Barminsky." Description, plans, and sections of centrifugal pump suction-dredge built in Holland for the Russian government. 800 w. Engng—Sept. 9, 1898. No. 22717 A.

Elevators.

Pneumatic Grain Elevators. (Ueber Pneumatische Getreideförderung.) M. Buhle. An illustrated description of the Duckham pneumatic system of handling grain as installed in various ports in England and on the continent. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 20, 27, 1898. No. 22903 each D.

Flow.

Calculation of the Flow of Water in Rivers and Canals. (Berechnung der Abflussmengen in Flüssen und Canalen.) A comparison of the new Bazin formula with that of Ganguillet and Kutter, showing both to be based upon the same principles. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 9, 1898. No. 22917 B.

Foundations.

Sinking Cylinder Foundations in Valparaiso. An illustrated account of the pneumatic foundation work for the new pier now under construction at Valparaiso. 1200 w. Eng, Lond.—Sept. 9, 1898. No. 22701 A.

Haulage.

See Electrical Engineering, Power.

Inundation.

New Orleans' Danger. From the *N. Y. Sun*. An account of the trouble from caving banks of the Mississippi, which threaten some of the most valuable sections. 2300 w. Bos Jour of Com—Sept. 3, 1898. No. 22511.

Levees.

The State Levees of Louisiana. A brief record of the work in Louisiana. There are at present 1194 miles of levees in the State, and 90 miles in Arkansas. 1200 w. Eng Rec—Sept. 24, 1898. No. 22887.

Lighthouses.

The Latest Improvements in the French Lighthouse System. Jacques Boyer. The first portion of a detailed account of the great advances in coast illumination made in France. Many illustrations are given of the improved "lightning flash" optical system. 3000 w. Engineering Magazine—October, 1898. No. 22992 B.

Regulation.

The Regulation of the Elbe and Moldau, and their Tributaries in Bohemia. (Die Flussregulierungen an der Elbe, Moldau und deren Nebenflussen in Böhmen.) Hugo Franz. A general review of the improvements made during the past 50 years, with map and tables of data. 7500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Sept., 1898. No. 22923 D.

Ship Canal.

The Lake Erie and Ohio River Ship Canal. William Gilbert Irwin. Discusses the economies that will result from the construction of this canal, giving figures from carefully compiled statistics concerning the traffic of this region, the cost, &c. 1700 w. Sci Am—Sept. 24, 1898. No. 22836.

The Manchester Ship Canal. A discussion of the financial position and prospects, based upon the half yearly report. The conclusion is that the earnings will for many years at any rate dissappoint the promoters. 1200 w. R R Gaz —Sept. 9, 1898. No. 22613.

Water Ways.

Geological Water Ways Across Central America. J. W. Spencer. A discussion of the geological and biological evidence of interoceanic connections. Ill. 5500 w. Ap Pop Sci M—Sept., 1898. No. 22440 D.

Weirs.

Recent Experiments upon the Flow of Water over Weirs. (Expériences Nouvelles sur l'Ecoulement en Déversoir.) H. Bazin. A continuation of the author's classic experiments, this series including dams of a great variety of profile, the results being verry fully tabulated. 18-000 w, 1 plate. Ann des Ponts et Chaussées—2 Trimestre, 1898. No. 22949 F+G.

IRRIGATION.

Mountain Irrigation.

Difficulties of Mountain Irrigation Engineering. H. A. Crafts. Illustrates various features of mountain construction known as North Fork ditch, in Colorado. 1600 w. Sci Am—Oct. 1, 1898. No. 23083.

Scientific Irrigation.

Irrigation as a Civilizer. Extracts from a paper by F. W. Blackmar, basing his plea upon social considerations, with discussion of the views presented. 3400 w. Gunton's Mag.—Oct., 1898. No. 23112 C.

MISCELLANY.

Bearings.

The Determination of Compass Bearings by the Dial of a Watch. (Comment on Peut s'Orienter dans la Campagne en Faisant Usage de sa Montre.) An astronomical explanation of the method with tables showing the exact method for various months for any hour of the day. 1500 w. La Revue Technique—Aug. 25, 1898. No. 22936 D.

Cement.

Natural Cement Plant at Speeds, Indiana. F. H. Lewis. With views of the mill and the quarry, an analysis of the stone, and a general description of the operation of the plant. 2000 w. Eng Rec—Sept. 10, 1898. No. 22733.

The Manufacture of Slag Cement. E. May, in *Stahl und Eisen*. A description of the manufacture and properties. 1600 w. Ir Age—Sept. 1, 1898. No. 22454.

The Relations of Hydraulic Cementing Materials to Sea Water. (Das Verhalten der Hydraulischen Bindemittel zum Meerwasser.) Nadory Nandor. A review of the investigations of Michaelis and of Tetmaier upon the resistance of Portland cement to the action of sea water. Two articles. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 26, Sept. 2, 1898. No. 22-914 each B.

Collapse.

Collapse of a Pier Shed, New York City. Detailing the circumstances under which a partially completed pier shed was blown down during a severe storm. 1200 w. Eng Rec—Sept. 10, 1898. No. 22739.

Colorado.

Notes of an Engineer in Colorado. W. P. H. A review of the engineering features of Colorado Springs and vicinity, of Pueblo, Florence and Cripple Creek, with some related matters of interest. 5500 w. Eng News—Sept. 1, 1898. No. 22463.

Columns.

Diagrams of Johnson's Straight Line Formula for Determining the Strength of Columns. John S. Fielding. Diagrams of interest to engineers with critical letter from Thomas H. Johnson. 800 w. Eng News—Sept. 22, 1898. No. 22832.

Land-Slides.

Land-Slides. Abstract of a discussion before the Institution of Civil Engineers, by Mr. Crowell, giving some especial instances of the behavior of sliding earth in connection with engineering works. 1000 w. Eng Rec—Sept. 10, 1898. No. 22734.

Mortar.

See Architecture and Building, Miscellany.

Pile Driver.

A New Pile Driver. L. S. and M. S. Ry. Five views and descriptive notes of a pile-driver possessing many features of interest. 800 w. Ry Mas Mech—Sept., 1898. No. 22553.

Regulator.

Discharge Regulator and Tests of 14-inch Redwood Water Main, near Los Angeles, Cal. A balancing pan-and-float system is used to control the discharge. Tests of flow for lengths from 4400 to 8900 feet of pipe are given and values of coefficients deduced. 1000 w. Eng News—Sept. 8, 1898. No. 22727.

Retaining Walls.

Earth Pressures on Retaining Walls. G. C. Maconchy. Indicates a simpler and more direct method of calculating the overturning moments, and endeavors to bring the theory within the range of practical utility. Part first recapitulates some of the existing methods. 800 w. Engng—Aug. 26, 1898. Serial. 1st part. No. 22565 A.

Sand.

See Architecture and Building, Miscellany.

Telemeter.

The New Zeiss Telemeter. (Le Nouveau Télémètre Zeiss.) The instrument is based on the exaggerated stereoscopic effect produced by separating the objectives of a field glass by the use of prisms. The method is fully described, and the instrument tested is said to have measured distances of 2000 metres with an error of about 3 per cent. 3000 w. La Revue Technique—Sept. 10, 1898. No. 22940 D.

Wind Pressure.

See Architecture and Building, Miscellany.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Trade.

American Trade in British India. Prepared by the Philadelphia Commercial Museum. Hints helpful to the export trade, with brief criticism of American methods, and information concerning iron and steel-made goods. 2500 w. Am Mfr & Ir Wld—Sept. 2, 1898. No. 22548.

Cardiff.

Cardiff as a Port. Considers the causes which have led to the phenomenal development during the last fifty years—the population increasing from 10,000 to 176,000. 3000 w. Col Guard—Sept. 16, 1898. No. 22882 A.

China.

A Recent Business Tour in China. C. A. Moreing. Summarizes the salient features of the chief cities, the internal and external political influences at work, the characteristics of the governing classes and the people, the opening for commercial and industrial expansion, and the means by which the work can best be accomplished. 6500 w. Nineteenth Cent—Sept., 1898. No. 22685.

The Industrial Interests of the United States in the Far East. Wharton Barker. An account of the author's experience in industrial enterprise in China, outlining the general policy which he believes to be necessary to insure success in developing foreign interests there. 3000 w. Engineering Magazine—October, 1898. No. 22991 B.

The Yangtse Valley and Its Trade. Archibald Little. A summary of the physical features, trade movement, business resources, and political aspects. 6000 w. Contemporary Rev—Sept., 1898. No. 22801 D.

Competition.

American Competition. A letter from Arthur Herschmann, praising the American activity and enterprise in business, with editorial comment. 3000 w. Engr, Lond—Aug. 26, 1898. No. 22577 A.

Congress.

The Trades Congress. Editorial discussing the proceedings of the Labor Parliament held at Bristol, England, with especial reference to the proposed regulation of hours of labor, rates of wages, and federation of interests. 2000 w. Engng—Sept. 9, 1898. No. 22718 A.

Cuba.

The Undeveloped Resources of Cuba. G. E. W. Reviews the industries, chiefly agricultural, which offer opportunities for expansion. 1300 w. Sci Am—Sept. 10, 1898. No. 22603.

French Market.

The French Market for American Goods. F. C. Chappel. Discussion of steps necessary to secure better and juster commercial treaties and to advance American trade in France. 1200 w. Am Mach—Sept. 1, 1898. No. 22518.

New Territory.

The Commercial Promise of Cuba, Porto Rico, and the Philippines. George B. Waldron. Considers some of the opportunities for trade opened to the United States by the war with Spain. 2200 w. McClure's Mag—Sept., 1898. No. 22438.

Japan.

The Foreign Trade of Japan. Statistics drawn from the report of Mr. A. H. Lay, Assistant Japanese Secretary to Her Majesty's Legation at Tokio. 3600 w. Ind & East Engr—Aug., 1898. No. 22686 D.

Puerto Rico.

Puerto Rico and Its Resources. Quotation from Mr. Austin, Chief of the U. S. Treasury Bureau of Statistics, descriptive of the population, finances, topography, trade, and industrial opportunities of the island. 4500 w. Arch & Build—Sept. 17, 1898. No. 22674.

CURRENCY AND FINANCE.

Coinage.

Curiosities of American Coinage. Alexander E. Outerbridge, Jr. The subject is presented under four heads—1, The Functions of Money; 2, The Early Colonial Coinage; 3, The Coinage of Private Individuals or Companies; 4, The National Coinage; giving many interesting and important facts. Ill. 5000 w. Ap Pop Sci M—Sept., 1898. No. 22441 D.

Fiat-Money.

The History of Fiat Money and Currency Inflation in New England from 1620 to 1789. Frank Fenwick McLeod. An able and scholarly review of the many foolish and fallacious schemes, their successive collapses, and the attendant periods of bankruptcy and repudiation. 7000 w. Ann Am Acad—Sept., 1898. No. 22684 H.

War Loan.

Lessons of Our War Loan. Frank A. Vanderlip. Reviews incidents of this popular loan and its phenomenal success, the immense amount of clerical labor involved, and the effect upon the financial standing of the United States. 4000 w. Forum—Sept., 1898. No. 22541 D.

GOVERNMENTAL CONTROL.

Grazing-Lands.

Our Public Grazing-Lands. Frederick V. Coville. Concerning the decadence of western grazing-lands, due to the present public-land laws. Considers the limitation of the amount of stock by a *per capita* license, and outlines a plan of limiting the amount of stock to the forage capacity of the area. 4800 w. Forum—Sept., 1898. No. 22544 D.

State Socialism.

Australian Experiments in Industry. Helen Page Bates. A full review and discussion of the development and present management of railways, telegraph, telephone, and other industrial enterprises under State ownership in the various Australian colonies. 6500 w. Ann Am Acad—Sept., 1898. No. 22683 H.

LABOR.

Benefit Funds.

Benefit Funds in the Lake Superior Iron Mining Industry. William G. Mather. President's address at the annual meeting of the Lake Superior Mining Inst. Suggestions for furthering the good condition of the workmen, such as relief funds, housing, physical condition of the miners, &c. 4400 w. Ir Td Rev—Sept. 1, 1898. No. 22513.

Disputes.

Conciliation Councils in Milan. Commentary on the proposed introduction into Milan of a system analogous to the Conseils de Prud'hommes; summarizes the law and explains the functions of the "colleges of probiviri," which are more than mere boards of arbitration. 1800 w. Arch, Lond—Aug. 26, 1898. No. 22645 A.

Electric Plants.

Municipal Plants. Prof. Bemis. Presented at Detroit meeting of the League of American Municipalities. Notes on the recent progress of municipal electric lighting, with discussion. 5000 w. Pro Age—Sept. 1, 1898. No. 22487.

Labor Handling.

How a Georgia Manufacturer Handles His Men. Wm. Miller. The system and rules which are said to be extremely satisfactory in a brickyard employing colored workmen. 900 w. Brick—Sept., 1898. No. 22610.

Strike.

The Cost of the Engineers' Strike. Summary of the Report of George Barnes, Secretary of the Amalgamated Society of Engineers (Br.), giving the financial statement of the strike, its cause and conclusion. 2300 w. Steamship—Sept., 1898. No. 22688 A.

Wages.

Rates of Wages and Hours of Labor. Comments on information given in the recent report of the Commissioner for Labor on "Changes in Rates of Wages and Hours of Labor in the United Kingdom." 1800 w. Jour of Gas Lgt—Aug. 23, 1898. No. 225c8 A.

Wages and Hours of Labor. Editorial on the report from the Labor Department of the British Board of Trade, urging the desirability of avoiding fluctuations in the rate of wages in hours of labor. 2000 w. Engng—Aug. 26, 1898. No. 22566 A.

MISCELLANY.

Address.

The British Association. A condensed report of the Bristol meeting, with an abstract of Sir William Crookes' remarkable presidential address. 2500 w. Eng, Lond—Sept. 9, 1898. No. 22705 A.

Combination.

An Anglo-American versus a European Combination. Richard Temple. Presents facts relative to the strength of the two combinations, giving interesting statements relating to trade, population, areas, sea-coast, industry and production, &c. 4500 w. N Am Rev—Sept., 1898. No. 22439 D.

A Rational Basis for International Co-Operation. Sir Nathaniel Barnaby, K. C. B. A discussion of the friendly relations between England and America, showing the rational basis for co-operation to be the community of interest in maritime affairs. 3000 w. Engineering Magazine—October, 1898. No. 22990 B.

Economics.

Foreign Statistics. Editorial on the economic position of England as shown in the "Statistical Abstract for the United Kingdom" and the "Statistical Abstract for the Principal and Other Foreign Countries." 1800 w. Engng—Sept., 16, 1898. No. 22873 A.

Exposition.

The Universal Exposition of 1900. (Exposition Universelle de 1900.) A review of the present state of exposition matters, with especial reference to the preparations being made by Switzerland for a full representation. 4000 w. La Revue Technique—Sept. 10, 1898. No. 22938.

India-Rubber.

India-Rubber Plantations. Gives possible explanations of the shortness of supply other than the scarcity of material, discusses the proposed cultivation of the Pará tree out of its natural home, not regarding it with favor, but thinks it possible that replanting of denuded territory with the indigenous tree might, in time, prove remunerative. 2000 w. Engng—Aug. 26, 1898. No. 22567 A.

New York as a Rubber-Manufacturing Center. Hawthorne Hill. Reviews the considerations which encourage the location of the manufacturing industries in this city. 1300 w. Ind Rub Wld—Sept., 1, 1898. No. 22434 D.

Some Recent Developments in Rubber Cultivation. Francis Child Nicholas. Discusses the interest in rubber planting in the British West Indies; the writer's views in regard to forestry cultivation and husbandry cultivation. 2000 w. Ind Rub Wld—Sept. 1, 1898. No. 22436 D.

Where Rubber is Plenty, but Gatherers Scarce. From a recent report of the British counsel. W. A. Churchill. Gives information relating to rubber-trees, method in use for curing rubber, and rubber-gathering in Brazil. 1200 w. Ind Rub Wld—Sept. 1, 1898. No. 22435 D.

Patents.

The Work of the Patent Office. A review of the report of the Comptroller of Patents (English), suggesting some improvements in the existing practice. 1500 w. Jour Gas Lgt—Aug. 30, 1898. No. 22634 A.

Petroleum Accidents.

The Report of the Petroleum Committee. Sharp criticism of the findings of the Parliamentary committee appointed to investigate the legislation affecting petroleum storage and the sale and use of mineral-oil lamps. 1200 w. Jour Gas Lgt—Aug. 30, 1898. Serial. 1st part. No. 22633 A.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Carbide.

The Calcium Carbide Works at Ingleton. F. J. A. Mathews. A description of the first plant erected in England according to the patents of M. Raoul Pictet. The charge is given a preliminary heating by the discharge gases, and the work is completed by the heat of the electric arc. 1800 w. Elect'n, Lond—Sept. 9, 1898. No. 22779 A.

The Manufacture of Calcium Carbide. Abstract of a paper by M. Nicolai, read before the Polytechnical Society at Berlin, reviewing the best methods of manufacture and formulating the important points. Reviews also an American consular report summarizing the condition of the industry in Europe. 1500 w. Gas Wld—Sept. 10, 1898. No. 22632 A.

Corrosion.

On the Electrolytic Corrosion of Water and Gas Pipes by the Return Currents of Electric Tramways. J. A. Fleming. Read before the British Assn. at Bristol. A discussion of the causes and conditions of pipe electrolysis. 5800 w. Elect'n, Lond—Sept. 16, 1898. No. 23008 A.

Electrolysis.

The Electrolysis of the Alkaline Chlorides. (Ueber die Elektrolyse der Alkalichloride.) H. Wohlwill. A very elaborate account of the researches of the author, showing the influence of variations in voltage and current density, and investigating the conditions accompanying the production of hypochlorites and chlorates. 10-000 w. Zeitschr f Elektrochemie—Aug. 4, 1898. No. 22982 H.

Gold Plating.

The Electrolytic Deposition of Gold. An abstract of a paper by E. Wohlwill in *Zeitschr. für Elektrochemie*, discussing principally the relations of current density and the temperature of bath to the results obtained. 1000 w. Elec Rev, Lond—Aug. 26, 1898. No. 22782 A.

Nitrogen.

The Electrical Fixation of Nitrogen. Sir William Crookes. Extracts from the presidential address before the British Assn. for the Advancement of Science. Calling attention to the need of some means of "fixing" atmospheric nitrogen. Gives figures demonstrating that it can be done electrically by high-tension discharges with extremely cheap power. 1500 w. Elec Wld—Sept. 24, 1898. No. 22834.

Ozone.

Ozone; its Production and Applications. A description of the Andreoli "ozoniser," which consists of grids bearing numerous points between which electrical discharges take place. 1200 w. Elec Rev, Lond—Aug. 26, 1898. No. 22780 A.

LIGHTING.

Bristol, Eng.

Notes on the Electric Lighting System at Bristol, with Special Reference to Auxiliary Plant. H. Faraday Proctor. Read before the British Assn. An outline of the system with results of the working of some of the auxiliary plant. Alternating current is supplied to private customers, and continuous current is used for the public street-lighting. 2500 w. Elec Rev, Lond—Sept. 16, 1898. No. 23012 A.

Central Stations.

Central Station Statistics. From the American Electrical Directory and Buyers' Manual for 1898. Interesting tables of the central station electric-lighting business of the United States. 600 w. Sci Am Sup—Sept. 17, 1898. No. 22818.

Chamber of Deputies.

The Electric Lighting of the Palais Bourbon, Paris. (Eclairage Electrique du Palais Bourbon, à Paris.) An illustrated account of the isolated plant of the palace of the French Chamber of Deputies, with plan of the building. The generators are driven by double cylinder gas engines. 1500 w. 1 plate. Le Génie Civil—Sept. 10, 1898. No. 22931 D.

Detroit.

The Success of the Detroit Municipal Electric Lighting Plant. An analysis of the report for the year ending June 30, 1898, showing that the city has been most successful in operating its own plant. 2500 w. Eng News—Sept. 8, 1898. No. 22724.

Economies.

Positive and Negative Economies in the Operation of Small Electric Light Plants. E. P. Roberts. An examination of successive stages of the work showing where gains or losses are most likely to occur. Two papers. 1800 w. Elec Engr—Sept. 8, 22, 1898. No. 22758.

Electric Plant.

The St. Joseph Sanitarium Electric Plant. H. B. Coho. An illustrated detailed description of a plant containing features of special interest, located six miles from Monticello, N. Y. 600 w. Elec Eng, N. Y.—Sept. 29, 1898. No. 23017.

Grove Lighting.

Electric Lighting at the Pitman Grove Camp Meeting. Bingham Hood. A quite unusual installation is described, using a series incandescent system, but differing from any other in having no street fixtures, shunt boxes or other cut-outs. Ill. 1000 w. Elec Eng, N. Y.—Sept. 1, 1898. No. 22457.

Screw Thread.

Report of the Committee on Standard Thread for Edison Lamps. (Bericht der Kommission zur Normirung von Edison Gewinden.) The full text of the report to the German Elektrotechnic Society, together with discussion. Enlarged profiles of the proposed thread are given, and the subject of gauges discussed. 3000 w. Elektrotech Zeitschr—Aug. 4, 1898. No. 22968 B.

Supply Cost.

Some Suggestions Relative to Determining the Cost of Electric Supply. M. E. Turner. A paper before the Ohio Electric Light Association discussing a method of distributing the various elements of expense in order to determine the cost of electric supply. 2000 w. W Elect'n—Sept. 10, 1898. No. 22766.

Testing.

Testing Arc Light Circuits. W. H. Markland. Showing the superiority of the voltmeter to the electric call bell for this work, and asserting the unsuitability of the galvanometer for arc circuits. 1000 w. Elec Engr, N. Y.—Sept. 8, 1898. No. 22757.

U. S. Capitol.

Electricity in the United States Capitol. Bushrod C. Washington, Jr. An illustrated account of the electric light and power plant in operation in the Capitol building at Washington. 2500 w. Elec Wld—Sept. 10, 1898. No. 22765.

POWER.

Electric Driving.

The Relative Efficiency of Single and Group Electric Driving and Transmission. (Vergleich der Wirtschaftlichkeit von Elektrischen Einzelbetrieb, Elektrischen Gruppenbetrieb und Transmissionsbetrieb.) E. Hartmann. A discussion of the various conditions under which the different methods give the best results. 3500 w. Die Elektrizität—Aug. 20, 1898. No. 22966 B.

Electric Storage.

Electric Storage in an Edison Station. George P. Low. Illustrates and describes the installation features, and the practical results obtained at the Edison station of the San Francisco Gas and Electric Co. 6800 w. Jour of Elec—Aug., 1898. No. 22545.

Haulage.

Electrical Canal Haulage. Editorial discussing the causes of the decline in transport by canal, and predicting a revival in consequence of the introduction of improved methods; particularly the use of electricity for hauling. 1000 w. Elec Rev, Lond—Sept. 9, 1898. No. 22785 A.

Hydraulic Power.

The Development of the Hydraulic Power of the Hudson River at Mechanicville. Fully illustrated article describing the development of 7000 h. p. and its electrical transmission to Schenectady. 3000 w. Am Elect'n—Sept., 1898. No. 22760.

Industrial Motors.

The Applications of the Electric Motor to Small Industrial Purposes and Its Effects on Trade and on the Community Generally. Alfred H. Gibbings. Read before the British Assn. Considers the reasons why its application has been confined to a few trades, and showing how large a sphere of influence it is destined to fill. 2800 w. Elec Rev, Lond—Sept. 16, 1898. No. 23014 A.

Johannesburg.

The Electric Power Plant of the Rand Central Electric Works. (Die Elektrische Kraftübertragungsanlage der "Rand Central Electric Works.") Walter Klug. A very fully illustrated account of the plant at Johannesburg, S. A. R., including map of the distribution of current to the gold fields. 6000 w. Elektrotech Zeitschr—Aug. 4, 1898. No. 22967 B.

Meters.

Electric Meters for Use with Accumulators. (Elektrizitätszähler für Akkumulatorenbetrieb.) H. Aron. An illustrated article showing various forms of the author's pendulum meter as applied to accumulator driving. 2000 w. Elektrotech Zeitschr—Aug. 18, 1898. No. 22970 B.

The Meters of the Electrical Company, formerly Schuckert & Co. of Nuremberg. (Zähler der Elektrizitäts A. G. vormals Schuckert & Co., Nüremberg.) J. A. Möllinger. A very complete account of the meters made by this well-known concern, for various currents and uses. 5000 w. Elektrotech Zeitschr—Sept 8, 1898. No. 22978 B.

The Meter's Relation to the Dividend. Caryl D. Haskins. Abstract of paper read before the Ohio Elec. Lgt. Assn., August, 1898. Gives advice on the size of meters for variable loads, emphasizes the importance of overload accuracy, and considers other points of interest. 3000 w. Elec Wld—Sept. 3, 1898. No. 22490.

Mine Transmission.

See Mining and Metallurgy, Mining.

Motors.

Alternating Current Motors of Great Starting Power. (Wechselstrommotoren mit Grosser Anlaufskraft.) Max Déri. A paper before the Electrotechnical Society of Vienna, discussing the best armature windings for the purpose. 3000 w, Elektrotech Zeitschr—Sept. 15, 1898. No. 22981 B.

Polyphase Asynchronous Motors. W. G. Rhodes. A description of the Boucherot motor, showing its high starting torque. 1000 w. Elec Rev—Sept. 2, 1898. No. 22784 A.

Multiphase.

Consideration of the Multiphase System for Central Station Service. W. S. Kelley. Discussing the most effective systems for distributing and utilizing multiphase currents for central station power plants. 3000 w, Elec Engr, N. Y.—Sept. 22, 1898. No. 22759.

Tests.

Some Tests with an Induction Generator. A. F. McKissick. Paper presented at meeting of Am. Inst. of Elec. Engs. at Omaha. Describes tests made. 2500 w. Elec Wld—Sept. 3, 1898. No. 22491.

Three-Phase.

Electric Power and Its Application on the Three-Phase System to the Bristol Wagon and Carriage Works. W. Geipel. Read before the British Assn. Discusses the causes of waste of coal in workshops and factories and how it may be obviated by the use of electricity; also the economy in labor, and the attainment of the maximum output of machine tools. 4200 w. Elec Rev, Lond—Sept. 16, 1898. No. 23015 A.

Transmission.

Electric Power of the Dennison Manufacturing Company. With plans showing the use of electric transmission for a manufacturing plant occupying a number of detached buildings. 1800 w. Eng Rec—Sept. 17, 1898. No. 22-745.

Transmission of Power by Electricity. Alexander Siemens. Read before the British Assn. A study in detail of the developments. 3800 w. Elec Rev, Lond—Sept. 16, 1898. No. 23-013 A.

TELEGRAPHY AND TELEPHONY.

Cables.

The Archæology of Submarine Telegraphy. J. J. Fahre. A historical résumé of the early work with submarine cables from the earliest experiments down to 1840. Two articles. 5000 w. Elec Engr, Lond—Aug. 26, Sept. 2, 1898. No. 22775 each A.

The New French Submarine Cables. (Les Nouveaux Câbles Sous-marins Français.) With sections of the various portions of the cables recently laid between Brest and New York, and between New York and Cape Haytien. 1000 w. Le Génie Civil—Aug. 27, 1898. No. 22-926 D.

Copper Wire.

The Introduction of Hard-Drawn Copper Wire. Thomas B. Doolittle. Statement regarding the researches of the writer leading to the use of this wire in the telephone service and the advantages. 800 w. Elec Eng, N. Y.—Sept. 29, 1898. No. 23020.

Fire Alarm.

The Fire Alarm Telegraph System of Baltimore, Md. C. B. Fairchild. Illustrated description. 1000 w. Elec Eng, N. Y.—Sept. 29, 1898. No. 23019.

Space Telegraphy.

Communication by Spark Telegraphy without the Coherer. (Die Abstimmung der Funkentelegraphie ohne Fritter.) Martin Tietz. An account of experiments in which the thermopile and the bolometer were substituted for the coherer. 3000 w. Elektrotech Zeitschr—Aug. 18, 1898. No. 22972 B.

Synchronism in Wireless Telegraphy. An account of experiments by Dr. Martin Tietz, in *Electrotechnische Zeitung*. 1100 w. Elec Rev, Lond—Sept. 16, 1898. No. 23011 A.

Wireless Telegraphy. Abstract of a lecture by Monsignor Molloy, delivered before the Royal Dublin Society, descriptive of the work of Marconi. 800 w. Arch, Lond—Sept. 2, 1898. No. 22648 A.

Telephone Call.

The Automatic Pendulum Telephone Call. (Les Postes Télephoniques à Appel Pendulaire.) L. Montillot. A description of the system installed by the Omnibus Company of Paris. A pendulum and dial system is used, by means of which any station can call any other, without interrupting communication. Two articles. 3000 w. L'Electricien—Aug. 20, 27, 1898. No. 22964 each B.

Valley Telephone Co.

The Exchanges of the Valley Telephone Company, Saginaw, Michigan. History of the formation of the company, with illustrated description of the exchanges, the underground work, cables, line construction and accessories. 3000 w. Elec Engng—Sept., 1898. No. 23-003.

MISCELLANY.

Address.

Address to the Mathematical and Physical Section. W. E. Ayrton. Delivered to Section A of the British Association, and dealing with the relations of mathematical and physical science to applied electricity and engineering. 3500 w. Elec Engr, Lond—Sept. 9, 1898. No. 22777 A.

Presidential Address before the International Magnetic Conference. A. W. Rücker. Abstract, with editorial. Protests against the interference of terrestrial observations caused by proximity of electric tramways, and discusses other subjects of interest to the association. 5000 w. Elect'n, Lond—Sept. 16, 1898. No. 23007 A.

Aluminium.

Aluminium as an Electrode in Cells for Direct and Alternate Currents. E. Wilson. A record of experiments made with aluminium plates as electrodes, using various solutions and currents. Serial. Part 1. 2000 w. Elec Rev, Lond—Sept. 9, 1898. No. 22787 A.

Armatures.

Armature Winding and Connections. Arthur L. Rice. A description of the Wenström windings, with diagram showing the manner in which the wire is laid upon the armature. 1000 w. Am Elect'n—Sept., 1898. No. 22763.

Battery.

The Jacques Carbon Battery. John W. Langley. Endeavors to show that no new theory need be put forth to explain the action of this battery, but only an old one applied. 1800 w. Jour Fr Inst—Sept., 1898. No. 22530 D.

Cell.

A Simple Form of Daniell Standard Cell. (Ueber eine Einfache Form des Daniell'schen Normalelementes.) O. Grotrian. Describes a simple form, sufficiently constant for practical use, and more readily made than the Clark or Weston cells. 2000 w. Elektrotech Zeitschr—Aug. 18, 1898. No. 22971 B.

Charging Cells.

A Comparison between Charging a Secondary Cell at Constant Potential and at Constant Current, More Especially as Regards Efficiency. A. A. Cohen and J. M. Donaldson. Read before the British Assn., Section A. Reports a series of tests to determine the efficiencies obtained with the two methods. 4000 w. Elect'n, Lond—Sept. 16, 23. Serial. 2 parts. No. 23006 each A.

Conductors.

The Formula for Most Economical Section of

Electrical Conductors. (Note sur la Formule Economique des Canalisations Electriques.) D. Dujon. A mathematical examination of Lord Kelvin's law, with applications to practical examples. 2500 w. La Revue Technique —Aug. 25, 1898. No. 22935 D.

The Relative Costs of Copper, Aluminium, and Iron, when used as Electrical Conductors. J. B. C. Kershaw. A comparison of the cost and relative conductivity of the three metals, showing that at present prices aluminium is the most expensive. 1000 w. Elec Rev, Lond—Sept. 2, 1898. No. 22783 A.

Currents.

Parallel and Series Arrangement of Alternating Currents of Different Curve Forms. (Parallel und Reihenschaltung bei Wechselströmen von Beliebiger Kurvenform.) G. Roessler. A discussion of the character of a combined current when the wave curves are other than sinusoidal in form; the subject being mathematically treated. 4000 w. Elektrotech Zeitschr—Sept. 1, 1898. No. 22976 B.

Door Openers.

Electric Door Openers for Elevators. Explains the action of pneumatic door openers and describes an electric operating device. Ill. 1200 w. Elec Eng, N. Y.—Sept. 29, 1898. No. 23018.

Dynamometer.

A New Transmission Dynamometer. William Ernest Dalby. Read before the British Inst. of Civil Engs. Treats of a new mechanism for measuring the deformation of the spring, and describes a self-contained dynamometer. Ill. 1800 w. Am Mach—Sept. 22, 1898. No. 22817.

Efficiency.

The Determination of the Efficiency of a 220 Kilowatt Generator and Turbine with Vertical Connecting Shaft. (Bestimmung der Elektrischen Verluste Eines mit einer Turbine Gekuppleten 220 Kilowatt Drehstromgenerators mit Vertikaler Welle.) K. P. Täuber. Details of the test are given, the total loss being about 5 per cent. 2000 w. Elektrotech Zeitschr—Sept. 1, 1898. No. 22977 B.

Electrical Accessories.

Modern Installation Accessories According to the Rules and Standards of the German Electrotechnical Society. (Ueber Neuere Installationsmaterialien nach den Sicherheitsvorschriften und Normalien des Verbandes Deutscher Elektrotechniker.) R. Hundhausen. With numerous illustrations of switches, fuses, cut-outs, and other accessories. 5000 w. Elektrotech Zeitschr—Aug. 25, 1898. No. 22973 B.

Electromotive Force.

The Dependence of Electromotive Force of a Galvanic Element upon the Thermochemical Relations. (Ueber die Abhängigkeit der Elektromotorischen Kraft Galvanischer Elemente von der Thermochemischen Daten.) G. Platner. Showing the existence of a relation between the galvanic and thermochemical action and their interdependence—Serial. Part I. 1800 w. Elektrochemische Zeitschr—Aug., 1898. No. 22985 H.

Exciting.

A Method of Exciting Continuous Current Generators with Half the Pressure at the Brushes. (Schaltungsanordnung zur Erregung von Gleichstrom Nebenschlussmaschinen mit der Halben Bürstenspannung.) A. Sengel. By the introduction of a contact ring and third brush, a current of half the brush voltage may be derived and used for excitation. The details of the method and its advantages are described. 3500 w. Elektrotech Zeitschr—Aug. 11, 1898. No. 22969 B.

Galvanometer.

The Ballistic Galvanometer and Some of Its Applications. W. H. Freedman. Explains the theory of the instrument, and gives mathematical demonstrations. 5000 w. Sch of Mines Quar—July, 1898. No. 22431 D.

Isolated Plants.

The Efficient Use of Steam and Labor in Isolated Plants. Percival R. Moses. A comparison of the various elements of cost in isolated plants and a study of the relation which they bear to the efficiency of the whole. 2500 w. Engineering Magazine—October, 1898. No. 22999 B.

Magnetism.

Terrestrial Magnetism. A. E. Cotterell. A discussion as to whether the earth is really a huge magnet, or merely the recipient of an ethereal line of force. Serial. Part I. 1200 w. Elec Rev, Lond—Sept. 9, 1898. No. 22786 A.

The Effect of the Fibrous Structure of Sheet Iron on the Changes in Length Accompanying its Magnetization. Edward Rhoades. Introductory remarks and description of experiments having for their object the determination of the effect which the grain exerts on the magnetic changes in length and in the magnetization. 4300 w. Phys Rev—Aug., 1898. No. 22798 D.

Mannfacturing.

Electrical Manufacturing Interests. Thomas Cummerford Martin. Discusses electrical manufacturing development in the United States and the conditions which favor it, with the future outlook. 2000 w. Chau—Oct., 1898. No. 22842 C.

Permeameter.

The Kath Industrial Permeameter. (Pérmeametre Industriel du Dr. Hubert Kath.) MM. Aliamet and Brunswick. The instrument is based upon that of Marcel-Deprez, and enables permeability to be determined within the limit required by practice. 2000 w. L'Electricien—Sept. 17, 1898. No. 22965 B.

Polarization.

The Polarization Capacity of Reversible Electrodes. (Polarisationskapazität Umkehrbarer Elektroden.) Elsa Neumann. A mathematical investigation based on the method of Warburg. 2000 w. Zeitschr f Elektrochemie —Aug. 18, 1898. No. 22983 H.

Recorder.

An Alternating Cycle Curve Recorder. Hugh L. Callendar. Describes a new piece of apparatus intended to reduce the labor involved in the study of alternating-current phenomena by means of the delineation of the curves which represent the mode of variation of the pressure and current, throughout the cycle. 4000 w. Elect'n, Lond—Aug. 26, 1898. No. 22594 A.

A Reliable Method of Recording Variable Current Curves. J. A. Switzer. Describes investigations carried on in the Physical Laboratory of Cornell University, in the hope of adding something to the work of Dr. A. C. Crehore. 3200 w. Phys Rev—Aug., 1898. No. 22799 D.

Resistances.

The Galvanometer in the Bridge System. W. J. Murphy. Reports some experiments made which yielded rather remarkable results and led to an investigation and gave an additional reason for the use of the D'Arsonval type of galvanometer for bridge work. 700 w. Elect'n, Lond—Aug. 26, 1898. No. 22595 A.

Rotary Converters.

The Rotary Converter in Street Railway Work. Louis Bell. Explains what the rotary converter is, how it operates in practice, and under what circumstances it becomes economically available for railway work. Ill. 5000 w. St Ry Jour—Sept., 1898. No. 22498 D.

Supply.

The Supply of Electricity to Large Districts. A review of the report of the Joint Parliamentary Committee as to prospective legislation upon the distribution of Electricity. Serial. Part 1. 2500 w. Eng, Lond—Sept. 9, 1898. No. 22702 A.

Transformer.

The Theory of the Transformer. (Theorie der Umformer.) Gisbert Kapp. The first instalment of a serial treating of the theory of the rotary converter, discussing the general principles upon which the transformation of currents is based. Part 1. 2000 w. Elektrotech Zeitschr—Sept. 15, 1898. No. 22980 B.

Voltage.

Voltage Curves in Breaking Inductive Resistances. (Spannungskurven bei Ausschaltung Induktiver Widerstände.) Fr. Natalis. A record of tests made upon coils with various windings and cores. The Joubert disc was used, and the data are given with the respective curves. 1800 w. Elektrotech Zeitschr—Sept. 1, 1898. No. 22975 B.

MARINE ENGINEERING.

Balancing.

The Taylor Method of Balancing Marine Engines. (Das Taylorsche Verfahren zur Ausbalanzirung der Schiffsmaschinen.) C. Fränzel. A review of the method originally given by D. W. Taylor in the Jour. Am. Soc. Naval Engineers, for determining the crank angles and distribution of forces to produce a minimum vibration. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 1898. No. 22902 D.

Cruiser Engines.

Engines of the French Armored Cruiser "Chanzy." Principal dimensions and brief illustrated description. 500 w. Engng—Sept. 16, 1898. No. 22870 A.

Indicating.

Indicating Marine Engines. Lewis M. Ellison. Directions for indicating, with a study of diagrams. 700 w. Engr, N. Y.—Sept. 15, 1898. No. 23063.

Marine Engine.

Modern Type of Vertical-Inverted Triple-Expansion Marine Engine. Illustrated description of a type which is being used on small vessels. 400 w. Marine Engng—Sept., 1898. No. 22806 C.

Ocean Liners.

Our Great Ocean Liners. Interesting information, with illustrations, from the latest edition of Rhodes' Steamship Guide. 1500 w. Transport—Sept. 16, 1898. No. 23049 A.

Rafts.

Sea-Going Rafts on the Pacific. E. K. Bishop. Describing the construction and manipulation of the great lumber rafts, the introduction of which has caused a revolution in the transportation of lumber between Pacific Coast ports. 35000 w. Engineering Magazine—October, 1898. No. 22998 B.

Rowing.

Some Interesting Rowing Experiments. E. Cuthbert Atkinson, in *Natural Science*. Describes a recording indicator for rowing experiments, the diagram and the method of treating it, giving some account of results obtained from 27 experiments. 3300 w. Sci Am Sup—Sept. 3, 1898. No. 22471.

Shipyard.

The Lorain Shipyard of the Cleveland Shipbuilding Co. With general plan showing the arrangement of the slips and buildings, also plan, section, and details of the 500 ft. dry dock. 1800 w. Eng News—Sept. 8, 1898. No. 22722.

Shipyard Work.

See Mechanical Engineering, Compressed Air.

Steamships.

Great Steamships. (Les Grands Paquebots.) M. L. de Chasseloup-Laubat. A general review of the great ocean liners, from the Savannah, 1819, to the Kaiser Wilhelm der Grosse, with many illustrations of notable vessels. 50,000 w. Bulletin de la Société d'Encour—Aug., 1898. No. 22932 G.

Submerged Ships.

Submerged Ships and Their Salvage. Fred Hood. Gives briefly the history of the attempts at rescue work, the manner of work, and the dangers encountered by divers. 2000 w. Chau—Oct., 1898. No. 22843 C.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boilers.

See Architecture and Building, Heating.

Boiler Selection.

The Choice of a Boiler. Editorial showing the importance of taking local conditions into account in the selection of a steam boiler, and the minor influence of first cost as compared with cost of maintenance. 1500 w. Eng, Lond—Sept. 2, 1898. No. 22709 A.

Coal Dust.

Novelties in Coaldust Firing Apparatus. From *Thonindustrie Zeitung.* Illustrated description of mixers and feeding apparatus. 900 w. Col Guard—Sept. 16, 1898. No. 22881 A.

Corrosion.

A Peculiar Case of Corrosion. An account of sudden and intense corrosive action in a boiler, with explanation. Ill. 1300 w. Locomotive—Aug., 1898. No. 22899.

English Practice.

Steam Boiler Practice in England. Gives the essential points of a paper by J. J. Steinitz, read before the Municipal Electrical Assn. (England). It gives the most advanced practice in England. 2500 w. Am Mach—Sept. 1, 1898. No. 22516.

Explosions.

Boiler Explosion at Buffalo, N. Y. Account of an accident at the National Starch Mfg. Co.'s plant, with description of the battery and the conditions before and after the explosion. 1000 w. Min & Sci Press—Sept. 10, 1898. No. 22678.

Boiler Explosions. A review of the Board of Trade inquiry into an accident to a Cornish boiler at Bradford. 1800 w. Eng Mech—Aug., 1898. No. 22597.

Feed Water.

The Engineering Chemistry of Boiler Waters. Henry Leffman. A paper before the Engineers' Club of Phila., reviewing the chief impurities, their source, action, and removal. 2800 w. Am Gas Lgt Jour—Sept. 19, 1898. No. 22640.

Flat Heads.

Investigation of Distortion and Resistance of Flat Heads. Prof. C. Bach. Reprinted from *American Machinist.* The investigations cover flanged heads of wrought and cast material, deducing formulæ. Ill. 1200 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22446 H.

Fuel Gas.

Dellwick's Water Gas. An illustrated description of the producer, the process, and the properties, cost, and applications of the gas. Translated from Teknisk Tidskrift by *The Iron Age.* 2000 w. Pro Age—Sept. 15, 1898. No. 22626.

Smoke. A reference to the cause of smoke, the possibilities of prevention by the use of gaseous fuel, and especially the Dellwick process as an economical solution. 1600 w. Pro Age—Sept. 15, 1898. No. 22625.

Injectors.

Boiler Feeding by Injectors. James Whitcher. A discussion of the objections to the injector as a boiler feeder, comparing its advantages and disadvantages. 1200 w. Elec Rev, Lond—Aug. 26, 1898. No. 22781 A.

Locomotive Boiler.

How to Lay Out a Locomotive Boiler. Henry J. Raps. Method of laying out the throat sheet and upper one-half of connection. Ill. 700 w. Loc Engng—Sept., 1898. No. 22550 C.

Mechanical Draft.

The Economical Aspects of Mechanical Draft with Special Reference to Central Stations. Walter B. Snow. Presents the conveniences and advantages claimed for mechanical draft, and its importance to central station managers. 1800 w. R R Gaz—Sept. 2, 1898. No. 22525.

Mining Boilers.

Steam Boilers for Mining Purposes. William Kent. The principles governing their economical and efficient use. The influence of local conditions on the size and type of boilers, and an impartial study of best types of boilers for varying conditions at mines. 3000 w. Mine & Min—Sept., 1898. Serial. 1st part. No. 22479 C.

Peat.

Compressed Peat as Fuel. A description of the peat bogs of Ontario, Canada, and the operations there conducted of compressing peat for steam-raising fuel. Comparative evaporative tests with peat and coal are given. 1200 w. Can Elec News—Sept., 1898. No. 22791.

Water-Tubes.

Water-Tube Boilers. J. Alvah Scott. A discussion of Mr. Darwin Almy's paper on this subject in the Feb. number, considering the elements that tend to shorten the life of water-tube boilers and the precautions necessary for their care, &c., both in the torpedo-boat boiler and for commercial service. 5400 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22444 H.

COMPRESSED AIR.

Air Lift.

The Lifting of Water by Compressed Air. (Druckluft-Wasserheber.) E. Josse. A review of the development of the air-lift, from the time of Löscher in 1797 to Pohlé at the present time, with examples of various actual installations. 4500 w. Zeitschr d Ver Deutscher Ing—Sept. 3, 1898. No. 22905 D.

Compressor.

Compression of Air by Direct Action of Water. Herbert W. Umney. From a paper read before the Society of Engineers. Deals with an improved method of compressing air, illustrating experimental plant and stating the advantages of the method. 3000 w. Ry & Engng Rev—Sept. 17, 1898. No. 22830.

Compressed Air Plant at Ainsworth, B. C. Describes and illustrates an apparatus for compressing directly by falling water, without the use of any moving mechanism. 1200 w. Can Elec News—Sept., 1898. No. 22790.

Liquid Air.

Liquid Air. George F. Barker. A lecture delivered at the Friends' Inst. Lyceum, Philadelphia. Part first reviews the history of the liquefaction of gases, giving some account of the work of various experimenters. 2500 w. Sci Am Sup—Sept. 24, 1898. Serial. 1st part. No. 22840.

Liquid Air, Its Production and Properties. Samuel A. Tucker. Briefly reviews the history of the liquefaction of gases, especially of air, and discusses the properties of liquid air, describing interesting experiments. 5500 w. Sch of Mines Quar—July, 1898. No. 22429 D.

Locomotive Works.

The Compressed-Air Plant in the Locomotive Works at Leinhausen near Hanover. (Die Pressluft-Einrichtungen der Lokomotiv-Werkstatt Leinhausen b. Hannover.) With plan of the works and numerous illustrations of pneumatic lifts, hammers, drills, and other tools. An extensive and interesting plant. 3000 w. Glaser's Annalen—Aug. 1, 1898. No. 22919 D.

Re-Heating.

Device for Re-heating Compressed Air in Pumps. Edward A. Rix, in *Modern Machinery*. Illustrated description of apparatus. 1000 w. Col Guard—Aug. 26, 1898. No. 22562 A.

Ship-Yard Work.

Experiences with Compressed Air in Shipbuilding and Ship-yard Work. William Burlingham. Interesting particulars of work done by pneumatic machines, with illustrations. 2500 w. Marine Engng—Sept., 1898. No. 22805 C.

ENGINES AND MOTORS.

Clearance.

Computing Clearance in Steam Engines. Illustrates and describes four methods of finding clearance. 1600 w. Power—Sept., 1898. No. 22557.

Compound Engines.

Compound Non-Condensing Engines for Office Buildings. Editorial review of all published data concerning advantages of simple and compound types. 1600 w. Eng Rec—Sept. 3, 1898. No. 22532.

Compression.

Experiments on the Compression of Steam in the Clearance Space. M. Dwelshauvers-Dery. Report of experiments demonstrating not only that compression is not detrimental, but that it is indispensable for the attainment of maximum efficiency. 7000 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22445 H.

The Compression of Steam in the Clearance Space. (Sur la Compression de la Vapeur dans l'Espace Mort.) Dwelshauvers-Dery. An account of the author's further tests upon the experimental engine at the university of Liége, together with a reply to the recent comments of Prof. Boulvin. 10,000 w. Revue de Mécanique —Aug., 1898. No. 22947 H.

Efficiency.

The Efficiency of Steam Engines. Editorial, together with the report of the Thermal Efficiencies Committee of the Institution of Civil Engineers, discussing the basis for a comparison of the efficiency of steam engines. A valuable paper. 5000 w. Elect'n, Lond—Sept. 2, 1898. No. 22778 A.

Engine Accident.

A Peculiar Engine Accident. Illustrates and describes the accident at the Tracy St. station of the Syracuse, N. Y., Rapid Transit Railway Co., on Aug. 1, 1898. 1300 w. Power—Sept., 1898. No. 22556.

Engine Frame.

Strengthening an Engine Frame. Charles A. Hague. Illustrates and describes repairs to a vertical steam engine which was threatened with serious breakdown. 1600 w. Am Mach—Sept. 22, 1898. No. 22815.

Engine Room.

Systematic Work in the Engine Room. W. H. Wakeman. Calls attention to details needing care. 2200 w. Sci Mach—Sept. 1, 1898. No, 22453.

Failures.

Engine Failures. Editorial on the last report of Michael Longridge, to the Engine, Boiler, and Employers' Liability Insurance Co., Limited. 900 w. Engng—Sept. 16, 1898. No. 22874 A.

Gas Engines.

Experiments on the Direct Use of Blast Furnace Gases in Motors. (Expériences sur l'Emploi Direct des Gaz des Hauts-Fourneaux dans les Machines Motrices.) Aimé Witz. A detailed account of the tests made at Cockerill's works at Seraing, Belgium. 2500 w. Revue Universelle des Mines—Aug., 1898. No. 22944 H.

Experiments with a Simplex Motor Using Blast-Furnace Gas. Account of an extended trial of a high-power single-cylinder engine, describing the manner and conditions of the test and giving many data. 2000 w. Gas Wld—Sept. 10, 1898. No. 22630 A.

Some Notes on the Modern Commercial Gas Engine. W. C. Peebles. A paper read before the North British Association of Gas Managers, sketching the history of the gas engine, the development of its important features, and making a particular argument for the engine made by the writer. 6500 w. Am Gas Lgt Jour—Sept. 12, 1898. No. 22637.

Some Notes on the Modern Commercial Gas-Engine. W. Carmichael Peebles. Read before the North British Assn. of Gas Managers. Gives briefly the history of the Otto cycle gas-engine, and the changes which have taken place since first brought out, recent improvements and the benefits from the invention. Also discussion. Ill. 5000 w. Jour of Gas Lgt—Sept., 1898. No. 22509 A.

Heat Motors.

The Theory of Heat Motors. (Zur Theorie der Wärmemotoren.) Donat Banki. A mathematical examination of the Carnot cycle, and a discussion of its applicability to actual motors. Many diagrams and tables. 7000 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 1898. No. 22900 D.

Indicators.

The Effect on the Indicator Diagram of Various Changes in the Valve, Eccentric or Governor Connections of an Engine. A. H. Eldredge. Gives diagrams taken by students in Sibley College, Cornell University, with explanations. 1000 w. Power—Sept., 1898. No. 22558.

The Indicator and Its Uses Aboard Ship. R. W. Jack. Read before the Inst. of Engrs. & Shipbuilders at Hong Kong. A somewhat elementary description of the indicator and its use, with discussion of typical diagrams. Ill. 7600 w. Steamship—Sept., 1898. No. 22-689 A.

Universally Incorrect Indicator Practice. Tecumseh Swift. Calls attention to some errors in the use of indicator diagrams. 1500 w. Am Mach—Sept. 15, 1898. No. 22814.

Oil Engine.

Campbell Portable Oil Engine. Brief description and illustrations of 20 h. p. petroleum engine. The jacket water is cooled and reused, and the engine is entirely independent of any fixed connections. 800 w. Engng—Sept. 2, 1898. No. 22713 A.

Thermal Efficiency.

The Thermal Efficiency of Steam Engines. The report of the committee of the Institution of Civil Engineers, in connection with a standard basis for steam engine trials. An important paper. Two articles. 3500 w. Engr, Lond—Sept. 2, 9, 1898. No. 22710 each A.

Valve Gear.

Port Openings and Eccentricity. (Kanalweite und Excentrizität.) A. Ehrlich. With diagrams showing the relation between the width of port and throw of eccentric. 1200 w. Zeitschr d Ver Deutscher Ing—Sept. 10, 1898. No. 22909 D.

Steam Engine of 500 H. P., with Zvonicek Valve Gear. (500 Pferdige Dampfmaschine mit Ventilsteuerung von Zvonicek.) Illustrating an inproved form of poppet valve gear with automatic cut-off. 800 w. Zeitschr d Ver Deutscher Ing—Sept. 3, 1898. No. 22906 D.

POWER AND TRANSMISSION.

Belting.

Notes on Belting ; Tests of Leather, Rubber, Cotton, and other Belts. G. R. MacLeod. From "Digest of Physical Tests." A very thorough discussion of stresses, joints, and fastenings, and of the results of tests on many specimens of many varieties of belting. 5800 w. Brick—Sept., 1898. No. 22609.

Gas Power.

The Gas Power Station of the Lausanne Electric Tramways. (Station Géneratrice à Gaz Pauvre des Tramways Electriques de Lausanne.) P. Leprince-Ringuet. Description and illustration of 400 h. p. plant in 3 units, using producer gas, and driving the electric generators for the Lausanne electric tramways. 1200 w. 1 plate. Le Génie Civil—Aug. 20, 1898. No. 22929 D.

Power Plant.

American Apparatus for the Metropolitan Electric Supply Company of London. Illustrations and description of the 2500 unit, generators and engines, as photographed while under construction. 1500 w. 1 plate. Am Elect'n—Sept., 1898. No. 22761.

Pulleys.

The Strength of Pulley Arms. C. H. Benjamin. Illustrates and describes a series of experiments on pulley arms, carried on in the mechanical laboratory of the Can. School of Applied Science, The tests were made on cast-iron pulleys, and steel-rim pulleys. General conclusions are given with tabulated results. 2300 w. Am Mach—Sept. 22, 1898. No. 22816.

SHOP AND FOUNDRY.

Boring.

Boring and Finishing Cylinders in the Horwich Shops of the Lancashire and Yorkshire Railway. F. J. M. Illustrated description of special machine-shop operations carried on in these works. 1300 w. Am Mach—Sept. 8, 1898. No. 22808.

Brass Founding.

A Talk on Brass Founding. Chas. Vickers. Read before American Foundrymen's Association. Reviews the peculiarities of the metal, the special difficulties, and the means for overcoming them. 3000 w. Foundry—Sept., 1898. No. 22696.

Casting.

A Phenomenal Piece of Bronze Casting. Description of the work of mouiding and casting the largest single piece of bronze ever poured in the United States—a statue of Pan. 3000 w. Sci Am—Sept. 10, 1898. No. 22604.

Cost Keeping.

Effective Methods of Finding and Keeping Shop Costs. Henry Roland. A complete account of the minutely-divided accounts of a signal manufacturing company, showing the precision with which costs estimated from previous records agreed with the results on the completion of work. 5000 w. Engineering Magazine—October, 1898. No. 22994 B.

The Card-Index System of Cost Keeping. Illustrated description of the methods used by the Bullard Machine Tool Co., of Bridgeport, Conn. 2500 w. Am Mach—Sept. 15, 1898. No. 22812.

Drilling.

Special Drilling Tools. A. H. Cleaves. Illustrated detailed description. 600 w. Am Mach—Sept. 15, 1898. No. 22813.

Gages.

A New System of Gages for the Planer. Illustrated description of a gaging appliance in use by the Bullard Machine Tool Co., Bridgeport, Conn. 500 w. Am Mach—Sept. 8, 1898. No. 22810.

Hardness Test.

A Test for Determining the Hardness of Cast Iron. C. A. Bauer. Read before American Foundrymen's Association. The test proposed is by counting the revolutions needed to drill to a certain depth under uniform conditions. Duplicates agree closely. 1300 w. Foundry—Sept., 1898. No. 22695.

Index Wheel.

Originating the Index Wheel of the Cornell Dividing Engine. H. B. M'Cabe. Sketch and description. 400 w. Am Mach—Sept. 8, 1898. No. 22807.

Ovens.

An Oven for Dry Sand Molds. I. B. Thomas. Illustrated detailed description of a down-draught oven which gave great satisfaction. 3000 w. Foundry—Sept., 1898. No. 22691.

Pulley Arms.

The Evolution of the Pulley Arm. R. D. Moore. Discusses the motives which actuated the designer of the curved arm, and strongly advocates the straight form. Ill. 1400 w. Foundry—Sept., 1898. No. 22692.

Rolling Mill.

A New Rolling Mill Arrangement. (Neue Walzenstrassenordnung.) E. Weber. A system of adjacent mills with rolls at different heights, by means of which the bars may be passed continuously from one to the next. 1500 w. Stahl und Eisen—Sept. 1, 1898. No. 22956 D.

Rotary Molds.

Rotary Molds for Casting Pig Iron. J. M. Hartman. Illustrated description of a casting machine and the accompanying arrangement of the troughs and the iron notch. Ill. 1300 w. Ir Age—Sept. 22, 1898. No. 22800.

Shop Operations.

The Educational Values of Machine Shop Operations. Abstract of paper by C. P. Benns, read at a recent meeting of the American Manual Training Assn. 2200 w. Am Mach —Sept. 8, 1898. No. 22809.

Superintendence.

Dividing the Responsibility of Foundry Superintendency. Thos. D. West. Argues against relieving the foreman of responsibility for securing right grades of iron in castings. 2600 w. Foundry—Sept., 1898. No. 22693.

Vice Work.

Hints on Vice Work for Young Fitters. F. H. Suggestions for holding work in the vice for the purpose of filing or other operations. Ill. 2000 w. Mech Wld—Aug. 26, 1898. No. 22583 A.

Winding.

Spring Winding Attachments. Describes fixtures used by the writer in the making of helical springs. Ill. 2500 w. Am Mach—Sept., 8, 1898. No. 22811.

Works.

The Works of Messrs. Brown, Boveri and Co. An illustrated description of this important Swiss electrical machinery works with especial reference to its prominence in connection with polyphase work on the continent. 3000 w. Elec Rev, Lond—Sept. 9, 1898. No. 22788 A.

MISCELLANY.

Address.

Sir J. Wolfe Barry's Address. Given before the Mechanical Science Section of the British Association at Bristol. 7000 w. Engr, Lond—Sept. 16, 1898. No. 22879 A.

Automobiles.

Description of the Mechanism of the New Serpollet Vehicles. (Description du Mécanisme des Nouvelles Voitures "Système Serpollet.") A sheet of details with description of the improved Serpollet generator, engine, and driving gear as applied to an automobile. 1500 w. 1 plate. La Revue Technique—Sept. 10, 1898. No. 22938 D.

New York's Electric Cab Service. A very complete paper showing the construction of the 100 motor cabs now in public service in New York, with an account of the practical operation of the work of the Electric Vehicle Company. 4500 w. Am Elect'n—Sept., 1898. No. 22762.

The Brouhot Automobile Carriage. (Voiture Automobile Brouhot et Cie.) Brief description, wlth illustrations of a break and a phaeton, together with a plan showing the driving mechanism. A petroleum motor is used, with a variable speed gear device. 800 w. 1 plate. La Revue Technique—Aug. 25, 1898. No. 22937 D.

The Cabs and Central Station of the Electric Vehicle Company of New York. Illustrated detailed description. 3500 w. Elec Eng, N. Y.—Sept. 1, 1808. No. 22458.

The Competition of Automobile Cabs. (Concours des Voitures de Place Automobiles) The official report of the recent competition of automobile cabs in Paris, under the auspices of the Automobile Club of France. A plate of profiles of the three routes is given, and illustrations of the vehicles. Two articles. 1 plate. 12,000 w. Le Génie Civil—Sept. 3, 10, 1898, No. 22930 each D.

The New Station of the Electric Vehicle Company. Illustrated description of the finely equipped station in New York City, with brief mention of the essential points and improvements in the vehicles. 3500 w. Elec Wld—Sept. 3, 1898. No. 22489.

Balance.

The Design and Construction of a Sensitive Laboratory Balance. N. R. Hopkins. A statement of the physical principles involved, of the proportions of the different parts of the apparatus, and the mechanical operations of its manufacture. Illustrated. 2200 w. Sci Am Sup—Sept. 10, 1898. No. 22606.

Beam.

The Statical Computations for a Beam Reinforced by a Catenary. (Zur Statischen Berechnung des durch einen Balken Versteiften Kettentragers.) Anton Rytir. A very full mathematical treatment for various conditions of loading, forming a valuable contribution to analytical mechanics. 10,000 w. Oesterr Monatschr f d Oeffent Baudienst—Sept., 1898. No. 22924 D.

Chimney.

The Highest Chimney in America. W. P. Hardesty. Illustrates and describes the stack of the Omaha and Grant Smelter at Denver, Colo., which is exceeded in height by but four in the world. 900 w. Eng News—Sept. 1, 1898. No. 22465.

Coal Handling.

The Transportation and Handling of Coal. (Ueber Kohlen-Transport-und Lagerungs-Einrichtung.) M. Buhle. A paper before the German Society of Mechanical Engineers, with descriptions and illustrations of the devices used at many continental ports and terminals. Three articles, four plates. 15,000 w. Glaser's annalen—Aug. 1, 15, Sept. 1, 1898. No. 22918 each D.

Enamel.

Enamels of High Expansibility for Use with Wrought or Cast Iron. (Etude d'Emaux à Hautes Dilatations pour Fonte ou Fer.) M. Saglio. A discusssion of enamels based upon various borates, such as borocalcite and pandermite, showing that enamels can be made of such expansibility as to be successfully used upon iron. 9000 w. Bulletin de la Société d'Encour—Aug., 1898. No. 22933 G.

Furniture.

Office Furniture, Engineering Department, Metropolitan Waterworks. Giving details of drawing cases, drawing tables, blue print apparatus, etc., as used by the Metropolitan Water Board, Boston. 3500 w. Eng Rec—Sept. 17, 1898. No. 22741.

Resistance.

Moments of Resistance and Core-Sections for Given Laws of Deformation. (Widerstandsmomente und Kernfiguren bei Beliebigen Formänderungsgesetz.) Fr. Engesser. A discussion, based upon Hooke's law of the proportionality of strain to stress, with formulas and tables for the computation of moments and sections. Two articles. 7500 w. Zeitschr d Ver Deutcher Ing—Aug. 13, 20, 1898. No. 22901 each D.

Rope Splicing.

A Rapid Method of Splicing Wire Ropes. W. H. Morris. Illustrates and describes a method by which a rope can be spliced in from twenty to thirty minutes. 700 w. Mines & Min—Sept., 1898. No. 22485 C.

Slide Rule.

The Slide Rule in Everyday Work. Angus Ballard. An explanation of its uses and advantages as a time-saver. 2700 w. Mines & Min—Sept., 1898. No. 22478 C.

Spinning.

The Moistening of the Air in Spinning and Weaving. (Die Anfeuchtung von Luft in Spinnereien und Webereien.) J. Körting. A paper showing the importance of maintaining the proper degree of moisture in the air of spinning and weaving factories, with microphotographs of the fibers. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 27, 1898. No. 22904 D.

Steam Pipes.

See Architecture and Building, Heating.

Testing.

International Association for Testing Materials. Notice of the first meeting of the American Section, with announcement of the appointments of the American members on the international committees. 800 w. Eng Rec—Sept. 10, 1898. No. 22735.

Transportation.

Transporting Heavy Masses without the Use of Wheeled Vehicles. W. F. Durfee. Describes a method of carrying a heavy weight a distance by manual power, in use by the Chinese. Ill. 900 w. Am Mach—Sept. 1, 1898. No. 22-517.

MILITARY ENGINEERING.

Armed Europe.

The Armed Strength of Europe. Table showing resources in the event of a general conflict, prepared for the *World Almanac* by Lieut. W. R. Hamilton. 650 w. Sci Am Sup—Sept. 3, 1898. No. 22470.

Armorclads.

The First Battle Between Modern Armorclads. An account of the battle at Santiago, on July 3, 1898, reprinted from the *Literary Digest*, and agreeing practically with official reports. 3000 w. Jour Am Soc of Naval Engs—Aug., 1898, No 22447 H.

Balloons.

The Balloon in Warfare. H. Hergesell. A review of recent achievements in æronautical science, due largely to the demands of modern warfare, discussing the systems of various countries in the use of the captive balloon. 5000 w. Forum—Sept., 1898. No. 22540 D.

Battleships.

United States Battleships, Maine, Missouri and Ohio. Gives the chief characteristics of these sea-going coast-line battleships authorized by Congress. 5500 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22450 H.

Destroyers.

Torpedo-Boat Destroyers. Data from circular issued by the Navy Department, giving the elements of design, machinery, etc. 2000 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22452 H.

Evaporating Plant.

Evaporating Plant of U. S. S. Rainbow. A description of the evaporating and distilling plant. 2000 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22448 H.

Gun Carriage.

Barbette Carriage for the U. S. 10-inch Breech-loading Rifle. With detailed illustrations and description, showing the general construction and the arrangement of the recoil mechanism. 1000 w. Engng—Sept. 2, 1898. No. 22712 A.

Monitors.

United States Monitors, Arkansas, Connecticut, Florida, and Wyoming. Extracts from a circular issued by the Navy Department, giving the elements of design. 1800 w. Jour Am Soc of Engs—Aug., 1898. No. 22451 H.

Naval Battle.

The Destruction of Cervera's Fleet. I. As Seen by an Eye-Witness on the "Brooklyn," Commodore Schley's Flagship. George E. Graham. II. As Seen by an Eye-Witness on the "New York," Admiral Sampson's Flagship. W. A. M. Goode. Very fully illustrated. 9800 w. McClure's Mag—Sept., 1898. No. 22437.

The Official Report on the Wrecked Spanish Warships. Abstract and summary of conclusions of the investigating board, with comparison of the results with the forecasts. 2000 w. Sci Am—Sept. 10, 1898. No. 22605.

Naval Parade.

Return of the Victorious Fleet from Cuba. An illustrated account of the naval parade of Admiral Sampson's fleet at New York, Aug. 20, 1898. 1200 w. Sci Am—Sept. 3, 1898. No. 22467.

Naval Warfare.

Ships of War in Action. Reviews the results of the naval warfare in the late Spanish-American war, giving interesting and valuable information. 5000 w. Engr, Lond—Sept. 16, 1898. No. 22877 A.

Torpedo Craft.

Discussion of the Merits of Torpedo Craft and Some of the Features of Design and Construction. William A. Fairburn. Part first discusses the uses and design of torpedo craft, the type of boat needed, the difficulties, &c. 4000 w. Marine Engng—Sept., 1898. Serial. 1st part. No. 22804 C.

U. S. S. Oregon.

Recent Performances of the U. S. S. Oregon. Charles A. E. King. An interesting report of the voyage of this vessel from Puget Sound to Florida, her fine condition, and her part in the battle of July 3, 1898. 1600 w. Jour Am Soc of Naval Engs—Aug., 1898. No. 22443 H.

MINING AND METALLURGY.

COAL AND COKE.

By-Products.

Modern Appliances for Recovery of By-Products from Coking Coal. A translation from the German, dealing with Westphalian practice. Summarizes the conditions affecting quantity and quality of distillation products and describes recovery apparatus. 1100 w. Am Gas Lgt Jour—Sept. 19, 1898. No. 22639.

The Recovery of By-Products in Coke Making. (Anlagen zur Gewinnung der Nebenproducte im Kokereibetrieb.) Rudolf Terhaerst. Notes on the construction of the ovens and the condensing apparatus for the recovery of tar, ammonia, and benzol. 2500 w. Stahl und Eisen—Aug. 15, 1898. No. 22953 D.

Valuation of Crude Carbolic Acid. Carl E. Smith. From the Am. Jour. of Pharmacy. Considers the impurities of the commercial article, the methods of examination, and the difficulties met. 3000 w. Am Gas Lgt Jour—Sept. 19, 1898. No. 22642.

China.

Coal and Iron in Eastern China. C. D. Jameson. An illustrated account of this region, with its geology, and the remarkable coal and iron field. 2800 w. Eng & Min Jour—Sept. 24, 1898. No. 23009.

Coal Dust.

Damping Coal Dust at German Collieries. A translation of the police ordinances concerning the sprinkling of dust in the collieries of the Dortmund district. 1800 w. Col Guard—Sept. 2, 1898. No. 22750 A.

Coke Manufacture.

The Use and Manufacture of Coke in the Iron and Steel Industries. Discusses the economic value of coke and the method of its preparation, referring to the experiments of M. Louis Campredon, and his conclusions. Describes the fuel which has been employed in the blast furnace, and the changes, cost and economy. 2000 w. Col Guard—Aug. 26, 1898. No. 22563 A.

Colliery.

Birley Collieries. A general description of the plants at East and West Birley, Derbyshire, with illustration of the picking bands. 1000 w. Col Guard—Sept. 9, 1898. No. 22752 A.

Rotherham Main Colliery, Yorkshire. A general description, with photograph of headgear and plans of workings, haulage, shafts, &c. 2500 w. Col Guard—Sept. 2, 1898. No. 22747 A.

Colombia, S. A.

A New Field for the Development of Coal and Petroleum. C. F. Zeilinger. Information concerning the extent and character of the coal and petroleum resources of Colombia, S. A., from one who resided in the country more than seven years. Ill. 1700 w. Ir & Coal Trds Rev—Aug. 26, 1898. No. 22580 A.

Entries.

Gob Entry vs. Narrow Entry. Joseph Cain. The methods of working at the Thomas mines, Whitwell, Tenn. A description of the two methods and the conditions under which the gob entry method is more economical than the narrow. Ill. 3000 w. Mines & Min—Sept., 1898. No. 22477 C.

Otto Ovens.

The Otto Coke Oven and the German Coke Industry. A compilation from two papers recently published in Germany, showing the enormous advance in by-product saving recently made in the Ruhr district, and the part played therein by the Otto oven, the structure and working of which are described. 4400 w. Ill. Ir & Coal Tr Rev—Sept. 9, 1898. No. 22672 A.

Preparation.

Mechanical Preparation at the Saint-Eloy Collieries, France. An abstract of a paper by M. de Margues before the Société de l'Industrie Minérale, describing the French methods of screening, cleaning, and washing coal. 2500 w. Col Guard—Sept. 9, 1898. No. 22751 A.

Southern Coal.

Southern Coal and Coke Review of one year's operations in the principal fields of the Southern United States. 1700 w. Mfrs Rec—Sept. 2, 1898. No. 22486.

Treveskyn Mine.

Treveskyn Mine. Illustrated description of the surface and haulage arrangements at this new mine of the Vulcan Coal Co., in the Pittsburg district. 1200 w. Mines & Min—Sept., 1898. No. 22480 C.

Victoria.

The Coal Resources of Victoria. Perry F. Nursey. Shows the progress and satisfactory position of the industry and the remarkable development since 1890. 1800 w. Ind & Ir—Sept. 16, 1898. No. 22886 A.

Washing.

Notes on Coal and Coke. C. A. Meissner. Read before the Mining Society of Nova Scotia. Deals with coal and coke for blast-furnace use, especially with reference to the comparative benefits of washing. 1200 w. Can Min Rev—Aug., 1898. No. 22588 B.

Water Shaft.

Gilberton Water Shaft. George B. Hadesty. The method employed for draining the Gilberton and Draper collieries; the reasons for its adoption; the methods employed in sinking and timbering and the machinery used in hoisting the water. Ill. 3000 w. Mines & Min—Sept., 1898. No. 22474 C.

COPPER.

Newfoundland.

Copper and Pyrites in Newfoundland. Robert H. Jones. Some account of these ores and other mineral deposits of the island. 2500 w. Can Min Rev—Aug., 1898. No. 22586 B.

Saxony.

The Mansfeld Copper Mines. (Le Mansfeld.) Alphonse Dory. Describes the geological features of the district, and the mines and smelters of the Mansfeld Company, in the Harz mining region of Saxony. 7500 w. Revue Universelle des Mines—Aug., 1898. No. 22946 H.

Volumetric Analysis.

A New Volumetric Method for the Determination of Copper. Richard K. Meade. Read before the American Chem. Soc. Description of a permanganate method which is said to be rapid and sufficiently accurate. 1300 w. Ind & Ir—Sept. 9, 1898. No. 22665 A.

West Kootenay.

Long Distance Transmission Plant of the West Kootenay Power and Light Company. An illustrated account of the development of the falls of the Kootenay River, in British Columbia. 2000 w. Can Elec News—Sept., 1898. No. 22789.

GOLD AND SILVER.

Assaying.

The Assay of Telluride Ores. Charles H. Fulton. Describes work undertaken to determine where the difficulty and losses lie, and if possible to remedy these defects of the assay by proper methods and precautions, giving conclusions. 1800 w. Sch of Mines Quar—July, 1898. No. 22432 D.

Cassiar.

The Mineral Wealth of Cassiar. Report of the Dease Lake country and the probable mineral wealth of the Stikine. 1600 w. Can Min Rev—Aug., 1898. No. 22585 B.

Coolgardie.

The Coolgardie, Australia, District. John Dwyer. Information of some of the mines about Coolgardie. 1800 w. Min & Sci Pr—Aug. 27, 1898. No. 22472.

Cyanide.

Cyanide Experiments upon Dry Ores of Southern Slocan District. W. S. Johnson. Gives the results of experiments carried out by the writer. 5000 w. Can Min Rev—Aug., 1898. No. 22589 B.

Practical Cyanidation of Tailings and Ores. Alfred S. Edgecombe. Remarks on the practical treatment of tailings and ores gained by some years' experience in Australia. 2500 w. Can Min Rev—Aug., 1898. No. 22587 B.

The Siemens & Halske Process in the Transvaal. (Der Siemens & Halske Prozess in Transvaal.) H. Pauli. Showing the extent to which the process has been introduced, and its advantages over the MacArthur-Forrest process. 1200 w. Zeitschr f Elektrochemie—Sept. 1, 1898. No. 22984 H.

Darien.

The Darien Gold-Mining Region in Colombia. Eduardo J. Chibas. A fully illustrated account of the re-opening of these ancient Spanish workings, with a description of their modern development. 4000 w. Engineering Magazine—October, 1898. No. 22995 B.

Gold Mill.

The Hadley, N. Y., Gold Mill and Its History. J. Nelson Nevius. Illustrates and describes the process which is being tried on a commercial scale at the mill of the Sacondaga Mining and Milling Co., near Hadley, Saratoga Co., N. Y. 1600 w. Eng & Min Jour—Sept. 3, 1898. No. 22519.

Idaho.

Mt. Caribou Gold Deposits. Arthur Lakes.

A description of the Teton mountain country of Idaho and the formations of the ores found. 1400 w. Mines & Min—Sept., 1898. No. 22476 C.

Kalgoorlie.

Mines of Kalgoorlie, Australia. John Dwyer. A letter descriptive of the various properties, the lodes, yields, and physical and financial condition, very favorable to the region. 2500 w. Min & Sci Press—Sept. 3, 1898. No. 22677.

Klondike.

A Winter's Work in the Klondike. Tappan Adney. Letter and illustrations giving an idea of the conditions prevailing in this region. 5500 w. Harper's Wk—Oct. 1, 1898. No. 23002.

Gold and Other Resources of the Far West. J. A. Latcha. A description of the rich mineral fields of the west, the steps necessary for their development and the changes of recent years. Urging specially the building of railroads through the rich mineral regions. 5000 w. Forum—Sept., 1898. No. 22543 D.

The Pilgrimage to the Klondike and its Outcome. Frederick Palmer. Gives briefly the history of gold-seeking in this region, the present conditions, and future outlook. 5500 w. Forum—Sept., 1898. No. 22542 D.

Mercur, Utah.

Gold Mines of Mercur. Don Maguire. A description of one of the most peculiar formations of gold ore in the world. History of the early difficulties met with in treating the ore, the resulting ups and downs of the district, and its final success. 3000 w. Mines & Min—Sept., 1898. No. 22484 C.

New Zealand.

The Gold Mines of New Zealand. (Les Mines d'Or de la Nouvelle-Zélande.) F. Schiff. A general descriptive paper, with illustrations of the more important workings. 2500 w. Le Génie Civil—Aug. 27, 1898. No. 22925 D.

Ores.

Deceptive Appearances of Ores. Arthur Lakes. Notes some common mistakes. 800 w. Mines & Min—Sept., 1898. No. 22481 C.

Placers.

The Gold Placers of the Eastern Oural Mountains, Russia. H. B. C. Nitze. A short outline of the geology, character of the beds and method of working. Illustrated. 1200 w. Eng & Min Jour—Sept. 10, 1898. No. 22600.

Slimes.

Discrepancies in Slime Treatment. W. A. Caldecott. Notes on the assays of slime residues for total gold, and on the determination of the specific gravity of dry slimes. Also discussion. 4000 w. Jour Chem & Met Soc of S. Africa—July, 1898. No. 22584 E.

West Kootenay.

Notes on Lardeau and Cariboo Creek Mining Divisions, West Kootenay, B. C. Harry Bush. An account of discoveries made, advantages, and general information of the district. 3000 w. Can Min Rev—Aug., 1898. No. 22590 B.

IRON AND STEEL.

Blast Furnaces.

The Management of Blast Furnaces. E. S. Cook. An account of the writer's experiences, discussing fluxing, fuels, ores, blast, management and modern construction. 10,500 w. Can Min Rev—Aug., 1898. No. 22591 B.

Brittleness.

Brittleness Produced in Soft Steel by Annealing. J. E. Stead. Read before the Iron & Steel Institute. Discusses the definitions of terms, the different kinds of brittleness, causes of its development, and remedies. 4000 w. Ir & Coal Tr Rev—Sept. 9, 1898. No. 22670 A.

Cementation.

The Micro-Chemistry of Cementation. John Oliver Arnold. Read before the Iron & Steel Inst., at Stockholm. Describes the details of the method, and reports the micro chemical analyses of a series of bars. 2300 w. Ir & St Trds Jour—Sept. 3, 1898. No. 22820 A.

Diagram.

A Diagram for Finding the Transverse Strength of Steel Rails. Diagram for computing the transverse strength for weights up to 100 lbs. per yd., with explanation by W. M. Wickham. 500 w. Eng News—Sept. 22, 1898. No. 22833.

Flux.

Flux Spar in Metallurgical Work. Discusses its use in the blast furnace, the open-hearth steel furnace, and the foundry cupola. 1000 w. Ir Trade Rev—Sept. 8, 1898. No. 22623.

Forgings.

A Comparison of the Hollow Bored Method and the Fluid Compression Hollow Forged Method of Making Steel Forgings. George H. Bryant. Illustrated description of methods used at the Krupp Works, and why they are used. Written discussion by H. F. J. Porter, with closure by author. 6800 w. Jour of W Soc of Engs—Aug., 1898. No. 22797 D.

Grangesberg.

The Grängesberg Iron-Ore Mines. A description of the occurrence of the ore, methods of exploitation and working, separation, power-installation, and labor conditions. 2700 w. Ill. Ir & Coal Tr Rev—Sept. 9, 1898. No. 22671 A.

Hot-Blast.

The Heating of the Blast for Blast-Furnaces. (Die Winderwärmung an den Hochöfen.) F. Braune. A discussion of the advantages of heating the blast, with illustrations and descriptions of the more recent hot-blast stoves. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 10, 1898. No. 22907 D.

Jones Process.

Carnegie Mixer Patent Sustained. An abstract of the opinion of Judge Buffington in the action of the Carnegie Steel Co. vs. the Cambria Iron Co., sustaining the complaint. 3200 w. Ir Trade Rev—Sept. 8, 1898. No. 22620.

Lake Superior Region.

Iron-Ore Manufacture at Marquette. Extended abstract from a report by John Birkinbine. The first portion deals with ore supply, production, transportation, fuel, flux, etc. 4000 w. Ind & Ir. Serial. 1st part. No. 22666 A.

Manganese Irons.

Manganese in Cast Iron and Some Experiments Thereon. Guy R. Johnson. Read before American Foundrymen's Association. Presents results of some physical tests suggesting commercial use for high manganese iron, especially for brake shoes. 2200 w. Foundry—Sept., 1898. No. 22694.

Metalloids.

On the Action of Metalloids on Cast Iron. Guy R. Johnson. Read before the Iron & Steel Institute, Stockholm meeting. A discussion of the effect of each element on the properties of the iron and on the state of the other metalloids, with tables of tensile tests in which each element in turn is varied, the others being held constant. 2800 w. Ind & Ir—Sept. 9, 1898. Serial. 1st part. No. 22667 A.

Rolling Mill.

See Mechanical Engineering, Shop & Foundry.

Slag.

Basic Slag in the Martin Process. (Thomasschlacke im Martinbetrieb.) O. Thiel. An examination of the chemical composition of the slag produced by the basic open hearth furnace with various kinds of charges. 3000 w. Stahl und Eisen—Aug. 15, 1898. No. 22954 D.

Solution Theory.

The Solution Theory of Iron and Steel. Hanns Juptner von Jornstorff. Read before the Iron & Steel Inst., at Stockholm. The paper is a continuation of the writer's researches on the application of the laws of solution to the case of iron and steel. 2500 w. Ir & St Trds Jour—Sept. 10, 1898. No. 22835 A.

Steel Works.

The Donnarfvet Works. A brief account of the works of Stora Kopparbergs Bergslags Aktiebolags and the Sandvik Works. Ill. 1200 w. Ir & Coal Trds Rev—Aug. 26, 1898. No. 22-579 A.

Sulphides.

On the Diffusion of Sulphides Through Steel. E. D. Campbell. Read before the Iron & Steel Inst. at Stockholm. A description of experimental work, and a statement of results. 1300 w. Ir & St Trds Jour—Sept. 3, 1898. No. 22819 A.

Swedish Iron.

Characteristic Features of Swedish Iron Ore Mining. G. Nordenstrom. Read before the Iron and Steel Inst., Stockholm. The geographical distribution of iron ores, their occurrence, nature and composition are considered, use of magnetic instruments in exploring, prospecting by means of diamond drilling, methods of working, ventilation, &c. 10,300 w. Col Guard—Aug. 26, 1898. No. 22561 A.

The Development of the Swedish Iron Industry. Richard Akerman. Read before the Iron and Steel Inst., Stockholm. Historical review. 6000 w. Col Guard—Aug. 26, 1898. No. 22-559 A.

The Iron Ore Deposits of Kiirunavaara and Luossavaara. Hjalmar Lundbohm. Read before the Iron and Steel Inst., Stockholm. An account of these large deposits in Sweden, describing their situation, area, quality, various types, &c. 4400 w. Col Guard—Aug. 26, 1898. No. 22560 A.

The Iron Ore of Northern Sweden. A narrative of the visit of the members of the Iron and Steel Institute to the Swedish mines, with valuable data as to the nature of the ores, methods of working, &c. Serial. Part 1. 2000 w. Engng—Sept. 2, 1898. No. 22714 A.

MINING.

Accidents.

Statistics of Mining Labour and Accidents. A review of the record of mining accidents for 1897, and a discussion of these with reference to the number of persons employed and the nature of the disasters. 2000 w. Col Guard—Sept. 2, 1898. No. 22749 A.

Dangers.

Mining Dangers. Editorial on the points brought out by a special inquiry, made recently, because of the belief that the number of accidents in the Albert district (N. S. W.) was greater than formerly. 1700 w. Engng—Aug. 26, 1898. No. 22569 A.

Explosives.

A Further Contribution to the Subject of Safety Mining Explosives. (Weiteres zur Frage der Sicherheitssprengstoffe.) Bergassesor Heise. A very complete examination of safety explosives, especially as regards chemical composition, and heat evolved during explosion. Four articles. 10,000 w. Glückauf—Aug. 20, 27, Sept. 3, 10, 1898. No. 22959 each B.

Kynoch Limited and the High Explosives Trade. An account of the manufactures and experience of this firm, near Birmingham, Eng., with blasting explosives. Ill. 3000 w. Ir & Coal Trds Rev—Sept. 16, 1898. No. 22885 A.

The Progress of Explosives. Perry F. Nursey. A comprehensive review of the last report of Col. Sir Vivian D. Magendie, taking up especially accidents and their causes and importations into the United Kingdom. 2000 w. Ind & Ir—Sept. 9, 1898. No. 22664 A.

Fire Damp.

Fire Damp and Underground Meteorology. Emile Harzé. A reply to article entitled "Fire-damp in its Relation to Meteorology," published in this paper Aug. 12, considering some of the statements open to criticism. 2800 w. Col Guard—Sept. 16, 1898. No. 22880 A.

Haulage.

Endless Rope Haulage at the Monopol Mine. (Flachscheibenhaspel mit Endlosem Seil auf Zeche Monopol.) An overhead cable hauling system is used, with independent engine; the cars being clamped to the cable. 1200 w. 1 plate. Glückauf—Aug. 13, 1898. No. 22958 B.

Underground Haulage. L. C. Morganroth. A comparison of the methods used in the anthracite mines of Pennsylvania. 2200 w. Mines & Min—Sept., 1898. No. 22482 C.

Mexico.

Mexican Methods of Mining. Describes the modus operandi of a typical Mexican mining company. 1700 w. Min & Sci Pr—Aug. 27, 1898. No. 22473.

Mine Accounts.

Keeping Mine Accounts. A. J. Yungbluth. Read at the Ironwood meeting of the Lake Superior Mining Institute. Discusses general principles, arrangement, grouping, and details. 2800 w. Ir Trd Rev—Sept. 8, 1898. No. 22624.

Mines Drainage.

The South Staffordshire Mines Drainage Scheme. E. B. Marten and Edmund Howe. Read at Birmingham (Eng.) meeting of the Inst. of Mining Engs. The paper deals more especially with the surface, and particularly with the Tipton district, where electric power is to be used. 3000 w. Col Guard—Sept. 16, 1898. No. 22883 A.

Mine Transmission.

Electrical Transmission of Power in the Ziegler Shaft, Nurschan. From a paper by F. Holzner in the *Oesterr. Zeitschr. f Berg-und-Hüttenwesen.* Sections of the workings are given, and illustrations of the various applications of the motors. 2500 w. Col Guard—Sept. 9, 1898. No. 22753 A.

The Electric Power Transmission in the Ziegler Mine at Nürschan. (Die Elektrische Kraftübertragungsanlage am Zieglerschachte bei Nürschan.) Ferdinand Holzner. A very full account of this extensive plant in which electricity is used for pumping, ventilating, hauling, and lighting. Three articles, 5 plates. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 15, 20, 27, 1898. No. 22961 each B.

Mining Method.

Mining Ore Bodies of Uniform Grade. E. F. Brown. Read at the fifth annual meeting of the Lake Superior Mining Inst. Describes a system of mining in successful operation at the Pewabic mine, Iron Mountain, Mich. 1000 w. Ir Trd Rev—Sept. 1, 1898. No. 22515.

Shaft Fires.

Precautions for Minimizing and Preventing Shaft Fires. Joh. Mayer. From *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Considers preventive, remedial, and subsidiary measures. Ill. 1500 w. Col Guard—Sept. 16, 1898. No. 22884 A.

Timber.

On an Improved Appliance for Drawing Timber in Mines. D. H. F. Matthews. Describes the improved appliance known as the Sylvester Pulling Jack. Also discussion. 2000 w. Can Min Rev—Aug., 1898. No. 22592 B.

MISCELLANY.

Aluminum.

Aluminum. A commentary upon its properties, production, and future. 1200 w. Builder —Aug. 27, 1898. No. 22653 A.

Bituminous Rock.

A Bituminous Rock Deposit in Santa Barbara County, California. A. S. Cooper. Illustrated description showing why it is difficult to locate with any great certainty a subterranean reservoir of petroleum. 1500 w. Eng & Min Jour—Sept. 3, 1898. No. 22520.

Brazil.

Explorations in the Lower Amazon District. (Auf der Lagerstättensuche im Unterem Amazonasgebiete.) F. Katzer. A review of the mineral resources of the region, including coal, iron, and gold, by the director of the Pará Museum. 3 articles. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 6, 13, 20, 1898. No. 22960 each B.

Clay.

Clay. G. J. M. Ashby. A paper read before the Chicago Ceramic Association. Reviews the origin, composition, classification, and uses of clay, and the processes and machinery used in potteries and brick works. 1400 w. Brick—Sept., 1898. No. 22608.

The Clay Resources of Alabama and the Industries Dependent Upon Them. Eugene A. Smith. Brief account of the clays and loams for building brick, material for vitrified brick, kaolins and stone-ware clays and fire-clays. 1200 w. Eng & Min Jour—Sept. 24, 1898. No. 23010.

Corundum.

Corundum in Ontario. An account of the deposits in the vicinity of Hastings and Renfrew, with some analyses and data of concentration tests. 1500 w. Eng & Min Jour—Sept. 10, 1898. No. 22599.

Cuban Minerals.

The Mineral Resources of Cuba. R. Cabrera. A summary of the occurrence and distribution of the deposits of asphaltum, copper, iron, manganese, and gold, with notes on former efforts to develop them. 2500 w. Eng & Min Jour—Sept. 10, 1898. No. 22601.

Exploring.

Magnetic Surveying for Iron Ores. G. Nordenström. A discussion of the various methods of exploring for iron ores by use of the magnetic needle. The Thalén and Tiberg instruments especially are described. 2000 w. Elec Engr, Lond—Sept. 2, 1898. No. 22776 A.

Fire Clays.

Fire Clays. T. C. Hopkins. What they are, where they are found, and how to test them to find their value. The various uses to which they are put and properties necessary for each. Their value in connection with economy in coal mining. Ill. 2800 w. Mines & Min—Sept., 1898. No. 22475 C.

High Temperatures.

A New Method of Treatment of Metals and Alloys,&c. (Ein Neues Verfahren zur Darstellung von Metallen und Legirungen, &c.) Dr. H. Goldschmidt. A discussion of the use of aluminum for obtaining high temperatures in connection with the fusion of metals and other substances. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 10, 1898. No. 22908 D.

Metallurgical Work.

Between the Mine and the Smelter—A Lecture Delivered Before the Graduating Class of the School of Mines. Albert R. Ledoux. Discusses problems affecting transportation when the smelter is located at a distance from the mine; also the questions of sampling and assaying. 5500 w. Sch of Mines Quar—July, 1898. No. 22430 D.

Michigan Quarries.

The Bayport, Michigan, Quarries. Illustrates and describes these quarries, and reports on the quality of the stone. 2400 w. Stone—Aug., 1898. No. 22259 C.

Mining Boilers.

See Mechanical Engineering, Boilers.

Oil Fields.

The Wyoming Oil Fields. Arthur Lakes. Brief review of what has been done in these fields, and a description of the geology of the Salt Creek fields. 900 w. Mines & Min—Sept., 1898. No. 22483 C.

Ore Deposits.

Swedish Iron Ore Deposits. Hjalmar Lundbohm. A summary of a general report made to the Swedish Board of Trade, and presented at the Stockholm meeting of the Iron and Steel Institute. Sections of the ore beds are given and the results of chemical analyses. 3000 w. Engng—Sept, 9, 1898. No. 22719 A.

Petroleum Accidents.

See Economics and Industry, Miscellany.

Platinum.

The Occurrence of Platinum in the Oural Mountains. R. Helmhacker. Generally descriptive of the several districts, the character of the places, the methods of working, and of the yields, and the occurrence of associated minerals. 4300 w. Min & Sci Pr—Sept. 10, 1898. Serial. 1st part. No. 22679.

Quarrying Ice.

Quarrying Ice in the French Alps. Illustrates and describes the process of cutting and transporting by endless cable, the machinery employed, and the cost and capacity of the plant. 900 w. Ice & Refrig—Sept., 1898. No. 22538 C.

Russia.

A Trip to Russia and the Ural Mountains. George F. Kunz. An account of a trip through a rich mineral district, discussing the resources, the finding and working of precious or ornamental stones, the washing for gold and platinum, with notes of general interest. 8500 w. Jour Fr Inst—Sept., 1898. Serial. 1st part. No. 22528 D.

Statistics.

Statistics of Mines and Quarries. A graphical summary of the general report relating to persons employed and accidents in the mines and quarries of the United Kingdom. 5000 w. Ir & Coal Tr Rev—Sept. 2, 1898. No. 22669 A.

Tenancy.

Tenant-for-Life's Power to Work Mines. A legal discussion of the rights of life tenants in connection with the development of mining property. 1200 w. Col Guard—Sept. 2, 1898. No. 22748 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene from a Hygienic Standpoint. (Acetylen vom Hygienischen Standpunkte.) Josef Vértess. An investigation of the products of combustion of acetylene with especial reference to their effect upon health. Pure acetylene is found very satisfactory in this respect. 2500 w. Gesundheits-Ingenieur — July 31, 1898. No. 22922 B.

A Sober Account of Acetylene. A favorable review of work by William E. Gibbs, entitled "Lighting by Acetylene. Generators, Burners and Electric Furnaces." 1100 w. Jour Gas Lgt—Aug. 23, 1898. No. 22507 A.

Some of the Properties of Acetylene Gas. An abstract translation of a paper read at Paris, by the French engineer Bouvier, which discusses some acetylene accidents and gives interesting data. 1700 w. Sci Am—Sept. 3, 1898. No. 22468.

Address.

Presidential Address at the Meeting of the Eastern Counties Gas Managers' Association, England. W. D. Child. Treating of matters connected with the manufacture and supply of coal gas. 7200 w. Gas Wld—Sept. 17, 1898. No. 22897 A.

Birmingham.

Centenary of Gas-Lighting in Birmingham. Eng. From the Birmingham *Post*. Historical review, giving figures of growth, output, and charges under the corporation. 1300 w. Arch, Lond—Sept. 2, 1898. No. 22651 A.

Gas Engineering.

Wayside Notes. T. S. Cleminshaw. Discusses some questions of interest to gas engineers. 4400 w. Jour of Gas Lgt—Sept. 13, 1898. No. 22847 A.

Incandescent Lighting.

An Afternoon in Ramsgate. Account of an interview with Mr. Valon, engineer to the Ramsgate corporation, chiefly touching incandescent burners, mantles, and gas consumption. 4000 w. Gas Wld—Sept. 3, 1898. No. 22627 A.

High-Pressure Incandescent Gas Lighting. Illustrated description of an automatically-operating compressor using water power. 1500 w. Gas Wld—Sept. 10, 1898. No. 22629 A.

Management of Works.

Waverley Association of Gas Managers: Inaugural Address of President M'Laren, at the Duns meeting in Scotland. Reviewing the special difficulties confronting the small works.

Discussion. 2500 w. Gas Wld—Sept. 10, 1898. No. 22631 A.

Meters.

Experiences with Prepayment Meters. Andrew Wilson. Read before the North British Association of Gas Managers. Describes the introduction and management of over 1000 such meters at Perth; the results were very satisfactory. Discussion. 2200 w. Am Gas Lgt Jour—Sept. 19, 1898. No. 22641.

Testing.

Official Gas Testing. Commenting severely upon the frequent and unexpected changes in methods and standards instituted by the (English) Standards of Light Committee. 1600 w. Jour Gas Lgt—Aug. 30, 1898. No. 22635 A.

Water Gas.

Dr. Bunte's Comments on Water Gas. Comments called forth by published papers by Dr. Strache and Dr. Leybold. 1600 w. Jour of Gas Lgt—Sept. 13, 1898. No. 22846 A.

Dr. Strache's Improvements in Lighting by Water Gas. Abstract translation of a paper in the *Journal für Gasbeleuchtung*. The improvement seems to relate to the apparatus for heating the blast. 1400 w. Jour Gas Lgt—Aug. 30, 1898. Serial. 1st part. No. 22636 A.

Oil Heating in Water Gas Manufacture. E. C. Jones. Abstract of a paper read before the Pacific Coast Gas Association, describing a special form of steam heater which is said to be extremely regular and satisfactory. Data of its performance are given. 1400 w. Gas Wld—Sept. 3, 1898. No. 22628 A.

The Chemical Composition and Technical Analysis of Water Gas. Edward H. Earnshaw. Gives the scheme of analysis of water gas, calling special attention to the presence of notable quantities of paraffines other than marsh gas, involving a modification of the methods of analysis commonly in use. 3500 w. Jour Fr Inst—Sept., 1898. No. 22526 D.

SEWERAGE.

Assessment.

Liability for Cost of Main Sewers. Review of a decision by Lord Pearson, of the Scottish Courts, upholding the corporation as against a disputing property owner. 1000 w. Arch, Lond—Sept. 2, 1898. No. 22652 A.

Purification.

Progress in Sewage Purification. W. Kaye Parry. Paper before the Royal Institute of Public Health arraigning recent claims to novelty and pointing out early investigations and successes in sewage disposal by clarification and filtration. 2000 w. Builder—Sept. 3, 1898. No. 22658 A.

Purification of Sewage. E. G. Barrow. Read before the Can. Assn. of Stationary Engineers. Refers especially to the general requisites for a proper land-filtration plant, with mention of sewage farming and chemical precipitation. 2300 w. Can Engr—Sept., 1898. No. 22697.

Sewage Purification by Intermittent Filtration at Central Falls, R. I. Description with plan. 1000 w. Eng News—Sept. 1, 1898. No. 22459.

Sewage Disposal.

Cambridge Sewerage Works. James H. Fuertes. Illustrated description of an English disposal system where lime is added to sewage and the latter filtered a few minutes later. 1000 w. Eng Rec—Sept. 3, 1898. No. 22533.

Sewage Sludges.

Recent Advances in the Bacterio-Chemical Study of Sewage and Polluted Waters. W. E. Adeney. Read before the Inst. of Civ. Engs. of Ireland. Discusses how these matters can be treated so as to prevent after putrefaction being set up in them. 3000 w. Engng—Aug. 26, 1898. No. 22571 A.

Sewer Pipes.

European Methods of Testing Sewer Pipes of Cement and Clay. A review of the preliminary report of M. Gary to the International Association for Testing Materials. Data concerning Continental practice are given. 1000 w. Eng News—Sept. 8, 1898. No. 22723.

Surface Drainage.

Damages for Inadequate Sewerage Works. Review of decisions of Supreme Courts of New York and Delaware concerning a city's responsibility for sewers too small to remove heavy rainfalls. 1100 w. Eng Rec—Sept. 3, 1898. No. 22531.

Ventilation.

Sanitary Excess. Wm. Watson. Strongly condemns the "American system" of interception traps on house drains, and cites Bradford, England, as an example of meeting successfully very difficult conditions. 2300 w. Can Engr—Sept., 1898. No. 22698.

STREETS AND PAVEMENTS.

Asphalt.

The Work of the Brooklyn Asphalt Laboratory. An account of the results of the work of Mr. G. W. Tillson in investigating the chemical nature of paving asphalts used in Brooklyn. 2000 w. Eng Rec—Sept. 17, 1898. No. 22742.

Pavements.

Defects of Creosoted Wood Block Pavements. F. A. Hetherington. Describes the experience in Indianapolis, Ind. The article is answered by Clarence A. Kenyon and Mr. Hetherington replies. Ill. 4200 w. Munic Engng—Sept., 1898. No. 22512 C.

Sidewalks.

Popular Village Sidewalks. Describes the system in operation in Mexico, N. Y., which has furnished a generous amount of concrete sidewalk pavement, thus greatly improving the town and facilitating pedestrian movement. 500 w. Eng Rec—Sept. 24, 1898. No. 22888.

Stone.

The Building and Road Stones of Massachusetts. C. L. Whittle. Historical commentary and review of the principal deposits and the character of the output. 3200 w. Eng & Min Jour—Sept. 17, 1898. No. 22680.

WATER SUPPLY.

Berlin.

The Water Works of Berlin. Jas. H. Fuertes.

With map showing location of works, also plan of filter beds. 1500 w. Eng Rec—Sept. 10, 1898. No. 22737.

Birmingham.

Birmingham Water Supply from Central Wales. An account of the water-supply works for Birmingham, England, by which the water of several streams in Central Wales is to be delivered to the city by gravity through an aqueduct over seventy miles long. Map, profile, and sections of aqueduct are given. 2000 w. Engr, Lond—Sept. 9, 1898. No. 22700 A.

Buffalo.

History of the Buffalo Water Works. Abstract of a paper prepared by Edward B. Guthrie, giving an account of the growth of one of the largest plants in the United States. 2800 w. Eng Rec—Sept. 24, 1898. No. 22894.

Drinking Water.

Drinking Water at Camp Thomas. P. A. Maignen. Discussion of the attempts made to purify the water, with suggestions of treatment necessary to produce a safe, agreeable water. 2700 w. Sci Am Sup—Sept. 24, 1898. No. 22839.

East London.

East London Water Supply. Editorial discussion of the cause of the present scarcity of water, and the difficulties with which the company has had to contend. 1600 w. Engr, Lond—Aug. 26, 1898. No. 22576 A.

Pipe Lines.

Old and New Methods Applied in Planning Pipe-Lines and Penstocks. F. M. F. Cazin. Presents a new method, conflicting with prevailing practice, and the reasons and causes why it should be adopted in planning supply-pipes. A question of hydraulics. 5000 w. Jour Fr Inst—Sept., 1898. Serial. 1st part. No. 22527 D.

Purification.

The Purification of Water. Editorial upon the relation of water supply and sources of contamination, discussing the various methods of sterilization and purification for drinking water. 1500 w. Engr, Lond—Sept. 9, 1898. No. 22703 A.

The Purification of Drinking Water. Henry E. P. Cottrell. An account of the experience in France and the late progress made there in water purification is given in part first. 1800 w. Engng—Aug. 26, 1898. Serial. 1st part. No. 22564 A.

Water Purification at Wilmington, Delaware. Illustrated description of filtration plant of a rated capacity of 10,000,000 gallons per day. The upward flow system is used. 3000 w. Eng News—Sept. 8, 1898. No. 22721.

Rome.

The Water Supply of Rome. Jas. H. Fuertes. A description of the ancient and modern aqueducts, with map, showing the sources of Roman water supplies. 1800 w. Eng Rec—Sept. 17, 1898. No. 22743.

Simla.

The Simla Water Works. An account, by Chas. E. V. Goument of the plant for the very varying demands of this summer resort of India. 3000 w. Eng Rec—Sept. 10, 1898. No. 22738.

Standpipe.

Racine's Standpipe and its Brick Casing. Read before the Am. W. W. Association. Describes the construction of the pipe and the means used in dealing with ice. 700 w. Am Arch—Sept. 17, 1898. No. 22676.

Tube Wells.

Tube Well Experiments at Lowell, Mass. George Bowers. From a paper presented at the Portsmouth meeting of the New Eng. Water-Works Assn. Describes the results obtained with the third set of tube wells sunk for the water-works of Lowell. 1500 w. Eng Rec—Sept. 24, 1898. No. 22893.

Vienna.

The Vienna High-Service Water Works. (Das Wasserwerk der Wiener Hochquellenleitung.) Franz Borkowitz. An illustrated account of the Breitensee division of the Vienna water supply, with profile, plan of works, and section of the covered reservoir. 2000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Aug. 19, 1898. No. 22910 B.

Water Famine.

The Dry Weather and the Water Supply. Account of an inspection of the East London Water Company's reservoirs, detailing the effect of drought on the river Lea. 12,000 w. Jour Gas Lgt—Sept. 6, 1898. No. 22636 A.

Water Meters.

The Results of the Meter System in Atlanta, Ga. Statement of the president of the water board concerning saving in coal for pumping and improvement in fire-protection resulting from universal use of meters. 800 w. Eng Rec—Sept. 3, 1898. No. 22535.

Water-Works.

The Steubenville, Ohio, Water-Works. Illustrates and describes the new plant in use since 1895. 2000 w. Eng Rec—Sept. 24, 1898. No. 22892.

MISCELLANY.

Destructors.

Refuse Destruction at Edinburgh. An illustrated account of the station and its equipment, the present condition and the history. 2800 w. Engr, Lond—Aug. 26, 1898. No. 22575 A.

Refuse Destructors. F. L. Watson. A paper upon the designing and construction of refuse destructors, with descriptions of the most important forms used in the United Kingdom. 2000 w. Engng—Sept. 9, 1898. No. 22720 A.

Fire Protection.

American Fire Protection. Summary of a report by Sir D. Colnaghi describing the organization and equipment of the Boston, Mass., fire department. 1500 w. Arch, Lond—Sept. 2, 1898. No. 22649 A.

Franchise Rights.

Remuneration to Cities for Franchise Rights. T. S. McMurray. Read at the Detroit meeting of the League of American Municipalities. Believes in municipal control of all public utilities, but as this must come gradually favors the paying of a fair remuneration for these rights. Discusses the problem. Also general discussion. 4500 w. Pro Age—Sept. 1, 1898. No. 22488.

Playgrounds.

Municipal Playgrounds in Chicago. Charles Zueblin. Reviews the experience of two months in these playgrounds, the difficulties, the success, and the needs of the future. Ill. 3000 w. Am Jour of Soc—Sept., 1898. No. 22792 D.

The Movement for Small Playgrounds. Sadie American. Reports the benefits derived from the establishment of playgrounds and outdoor gymnasiums, describing those established in various places. 4500 w. Am Jour of Soc—Sept., 1898. No. 22793 D.

Public Health.

Congress of the Royal Institute of Public Health. Report of the presidential and other addresses dealing with subsoils, nuisances, sewage disposal, sanitation, and kindred topics. 5000 w. Builder—Aug. 27, 1898. No. 22654 A.

Trading.

Municipal Trading. Abstracts of papers discussing the subject of the limits of municipal trading in the Section of Economic Science and Statistics, at the meeting of the British Assn. 2300 w. Arch, Lond—Sept. 16, 1898. No. 22898 A.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accident.

The Wellingborough Accident. Illustrated account of an accident on an English railway. 900 w. Engng—Sept. 16, 1898. No. 22872 A.

Train Accidents in the United States in July. A brief description of each, with classified summary. 4000 w. R R Gaz—Sept. 9, 1898. No. 22617.

Fast Runs.

The Two Fastest Long Distance Runs Without Stop. An account of the locomotive performance of the Empire State Express of the N. Y. C. & H. R. R. R. and the Cornish Express of the Great Western Railway, England. Ill. 2500 w. Sci Am—Sept. 3, 1898. No. 22469.

Firemen.

Instructing Firemen. Editorial calling attention to some things firemen should be taught, and referring to the discussion to be held at the convention of the Traveling Engs. Assn. on "How can the traveling engineer best instruct and assist firemen in the economical firing of locomotives?" 1000 w. Loc Engng—Sept., 1898. No. 22551 C.

Military Railways.

The Working of Railways in Military Operations. W. L. Derr. A discussion of the need for greater knowledge and experience in railroading in military operations, commenting on the manner in which the subject has hitherto been neglected by army officials, and suggesting lines upon which it should be developed. 3500 w. Engineering Magazine — October, 1898. No. 22996 B.

New Zealand.

New Zealand Railways. Editorial criticism on the management of these state railways. 1200 w. Engng—Sept. 16, 1898. No. 22875 A.

Signalling.

Some Elementary Notions about Signals. A statement and exposition of four desirable ideals, not incompatible with the restrictions which frequently surround a small or impoverished road. 2000 w. R R Gaz—Sept. 9, 1898. No. 22619.

Statistics.

Statistics of Railways in the United States for the year ending June 30, 1898. Extracts from the advance abstract of the tenth annual report furnished by Henry C. Adams. 1500 w. Eng News—Sept. 1, 1898. No 22466.

FINANCIAL.

Earnings.

Hopeful Railroad Earnings Returns. Reports the very satisfactory conditions for the month of August, with the prospects of even more favorable conditions for the future. 1800 w. Bradstreet's—Sept. 17, 1898. No. 22803.

LEGAL.

Light Railways.

An English Light Railway. A discussion of the principal clauses of the charter of the Crowland & District Light Railway, showing how the very strict regulations as to railroad building have been relaxed to permit construction where a standard railroad would be unprofitable. 2200 w. R R Gaz—Sept. 9, 1898. No. 22616.

State Regulation.

State Regulation of Railroads in Great Britain. Editorial on the Fishguard scheme and the action of the British Parliament. 1200 w. R R Gaz—Sept. 23, 1898. No. 22865.

Swiss Railroads.

The Nationalization of the Railroads in Switzerland. M. Horace Micheli. Gives the history of the railroads in Switzerland and the arguments presented which finally secured the management of the railroads by the state. 4800 w. Ap Pop Sci M—Sept., 1898. No. 22442 D.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air-Brake Instruction. A report presented by a committee to the sixth annual convention of the Traveling Engs. Assn. at Buffalo. Suggestions relating to methods to be taught, and points for instruction. 5000 w. Ry Age—Sept. 23, 1898. No. 23005.

Air-Brake Hose.

Specifications for Air-Brake Hose. Synopsis of paper by Arthur M. Waitt, read at convention of Master Car Builders' Assn., with comments of the trade, and by the editor. 4500 w. Ind Rub Wld—Sept. 1, 1898. No. 22433 D.

Brake-Beams.

Mechanics of the Cambered Brake-Beam. Irving P. Church. The object of the paper is to determine the stresses induced in the various members of the brake-beam when employed in pressing the brake-shoes at its extremities against the car wheels; and also the deflection of the middle point at the same instant. 2500 w. Jour Fr Inst—Sept., 1898. No. 22529 D.

Buffet Car.

A Novelty in Buffet Cars—C. G. W. Ry. Illustrates and describes a decidedly novel and pleasing car recently placed on the Chicago-St. Paul division of this road. 500 w. Ry Mas Mech—Sept., 1898. No. 22554.

Car Heating.

Heating Cars by Steam on the Paris-Lyons-Mediterranean Railway. (Chauffage des Trains par la Vapeur sur le Réseau Paris-Lyons-Mediterranée.) M. Mottet. A general description of the apparatus used, with plates of details of connections, valves, radiators, &c., and diagrams of the results of tests. 4000 w. 4 plates. Rev Gen des Chemins de Fer—Aug., 1898. No. 22942 G.

Car Lighting.

Electric Lighting of English Railroad Trains. The systems which have been tried in Great Britain and on the continent are described, especially the Stone system. 1600 w. R R Gaz—Sept. 16, 1898. No. 22823.

Railway Carriage Lighting by Compressed Oil Gas and Acetylene. Giving an illustrated account of the plant used in Berlin for an oil-gas enriched with acetylene and compressed in tanks for lighting carriages on the Prussian State Railways. 1000 w. Engr, Lond—Sept. 9, 1898. No. 22704 A.

Coal Car.

Double Hopper-Bottom Coal Car, 100,000 lbs. Capacity, Northern Pacific Railroad. Elevation, plan, sections and truck, with description. 600 w. Ry & Engng Rev—Sept. 10, 1898. No. 22825.

Headlights.

Searchlight Attachment for Headlights. Brief illustrated description of a simple arrangement, devised by John S. Thurman, for enabling the engineer to adjust his headlight on the searchlight principle. 300 w. Ry Age—Sept. 16, 1898. No. 22824.

Ladle Car.

A Car for Carrying Molten Metal. Brief illustrated description of a car used by the Carnegie Steel Co. 300 w. Ry Age—Sept. 23, 1898. No. 23004.

Locomotive Boiler.

See Mechanical Engineering, Boilers.

Locomotives.

Consolidation Locomotives—Burlington & Missouri River Railroad. Illustrated description of engines for freight service in the Black Hills. 350 w. Am Eng & R R Jour—Sept., 1898. No. 22456 C.

Four-Cylinder Express Locomotive. Illustrated description of a powerful English engine, designed by Dugald Drummond, of the London & South-Western Ry., with profile graphically recording its performance, and a set of indicator diagrams. 450 w. Engr, Lond—Aug. 26, 1898. No. 22578 A.

Narrow Gauge Locomotive, Soudan Railway. Illustration and brief description, also showing the method of transporting a gun boat in sections over the narrow gauge Soudan Railway. 200 w. Engr, Lond—Sept. 2, 1898. No. 22707 A.

New Mogul Locomotives of the Chicago Great Western Railway. Illustrated description, general dimensions and special equipment of two freight locomotives recently put on this road. 1200 w. R R Gaz—Sept. 23, 1898. No. 22864.

Peculiar Locomotives. Illustrated description of two old locomotives on the Pacific coast, the property of the Oakland Nail Works. 600 w. Loc Engng—Sept., 1898. No. 22549 C.

Rogers Locomotive Company Compound System. Illustrated description of this system of compounding locomotives. 1300 w. Loc Engng—Sept., 1898. No. 22552 C.

The New Express Locomotives of the French State Railways. (Les Nouvelles Machines d'Express du Réseau de l'Etat Français.) With illustrations of the four-cylinder compound engines, and of the simple express engines recently put into service. 1800 w. La Revue Technique—Aug. 25, 1898. No. 22934 D.

The New Great Northern Engines and Their Work. Charles Rous-Marten. Introductory remarks on the changed conditions which make necessary more powerful engines, with information concerning the engines designed by H. A. Watt, especially No. 990, giving the results of these journeys illustrative of its working. 3800 w. Engr, Lond—Aug. 26, 1898. No. 22574 A.

Locomotive Works.

See Mechanical Engineering, Compressed Air.

Trucks.

Metal Trucks for Freight Cars. Giving descriptions of the principal varieties used in the United States, with editorial upon the general advantages of metal over wood for trucks. 5000 w. Eng News—Sept. 15, 1898. No. 22728.

Swivel Trucks Used on American Cars. (Trucks Articulés de Voitures et de Wagons Usités aux Etats-Unis). M. Demoulin. A general account of the various trucks used in the United States, especially in comparison with the rigid axles of European practice. 7500 w. 4 plates. Rev Gen des Chemins de Fer—Aug., 1898. No. 22941 G.

NEW PROJECTS.

Alaska.

The First Railway to the Alaska Gold Fields. Illustrations showing some of the difficulties encountered in building the road from Skagway, Alaska, via the White Pass to Fort Selkirk, N. W. T., a distance of 380 miles. 600 w. Ry Age—Sept. 2, 1898. No. 22546.

Aviemore Railway.

The Aviemore Railway. Description of the constructional and scenic features of the line, which has been under construction for seven years and is just about to be opened for traffic. 1600 w. Arch, Lond—Sept. 2, 1898. No. 22649 A.

Central London.

The Central London Railway. A review of the traffic relations of the line, its general characteristics, and equipment. 2000 w. Br Arch —Sept. 2, 1898. No. 22661 A.

Ceylon.

Ceylon Railway Extensions. Comments upon the severe engineering difficulties often met in India, and briefly summarizes the climatic and topographic obstacles encountered in certain cases. Ind Engng—Aug. 13, 1898. No. 22802 D.

China.

American Contract for a Railroad in China. Brief account of road to be built from Han Kow to Canton. Map. 500 w. R R Gaz—Sept. 23, 1898. No. 22863.

Railways in China. Editorial on the recent developments and importance of the railway question in China, calling attention to the present position of the British government. 1800 w. Engng—Aug. 26, 1898. No. 22568 A.

Congo.

The Congo Railroad. From *L'Illustration.* Particulars concerning this railway, its route, construction and great importance. 2500 w. Sci Am Sup—Sept. 24, 1898. No. 22838.

Cripple Creek, Colo.

The Railways of the Cripple Creek, Colo., Mining District. W. P. Hardesty. Gives brief descriptions of the various railways, both steam and electric, as well as views of various portions, and a topographical map of the region. 2000 w. Eng News—Sept. 8, 1898. No. 22725.

East Africa.

Railway Construction in German East Africa. From a lecture delivered by Mr. Bernhard before the Bergischer Bezirksverein, translated and published in the Bulletin of the International Railway Congress. The territory is four-fifths as large as Germany, and contains four million inhabitants. An account is given of the work thus far projected or constructed toward providing better means of transportation, with some account of the difficulties. 1700 w. Ry & Engng Rev—Sept. 3, 1898. No. 22555.

Korea.

The First Railway in Korea. Interesting particulars of the railway being built by the Seoul & Chemulpo Ry Co. 600 w. Eng News—Sept. 1, 1898. No 22460.

Mallaig Railway.

The Mallaig Railway. An illustrated account of this railway, being constructed in the Scottish Highlands, which, from a scenic and historical point of view, will be almost unrivalled. 3300 w. Engr, Lond—Sept. 16, 1898. No. 22878 A.

Rack Railway.

The Nilgiri Rack Railway. A plan and section, with four views of the first rack railway in India, now nearly completed. Brief description. 700 w. Engng—Sept. 16, 1898. No. 22871 A.

Siberian Railroad.

Quinquennial Report of the Committee for Building the Siberian Railroad. Translated from the *Zeitung Der Vereins Deutschen Eisenbahn-Verwaltungen.* Reports the work accomplished, the work under way, and to be undertaken. 1500 w. R R Gaz—Sept. 16, 1898. No. 22822.

Simplon.

The Simplon Undertaking. (L'Entreprise du Simplon.) An account of the work involved in the construction of a railway across the Simplon Pass, including the Simplon tunnel of over 12 miles long. The total outlay is to be 70,000,000 francs. 1500 w. Moniteur Industriel—Sept. 10, 1898. No. 22943 G.

South Africa.

Railroad Building in South Africa. Summary of the existing and proposed railways in the Orange Free State, South African Republic, and Rhodesia, with map and quotation from report of Gen'l Mgr. of Rail Roads of the Cape of Good Hope referring to the Bechuanaland R.R. 800 w. R R Gaz—Sept 9, 1898. No. 22614.

Underground Railroad.

The Waterloo and City Railway, London. W. B. Paley. A general description of the tunnels, lighting, equipment and train movement. 1000 w. R R Gaz—Sept. 9, 1898. No. 22615.

U. S. Railroad.

Nearly 1,300 Miles of New Road in the First Half of 1898. Revised report giving figures in detail by States. 1400 w. R R Gaz—Sept. 2, 1898. No. 22524.

PERMANENT WAY AND FIXTURES.

Africa.

The Railways of Africa. (Die Afrikanischen Eisenbahnen.) With map, showing the existing roads and proposed constructions. 1500 w. Stahl und Eisen—Sept. 1, 1898. No. 22957 D.

Chili.

The Taltal Railway. (Die Taltalbahn.) Deodoro Moegle. An account of this Chilian railway, extending from Taltal on the coast, to Cachinal, at an elevation of over 9000 feet in the Andes. The road affords an outlet for saltpetre, as well as gold, silver, and copper to the coast. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 26, 1898. No. 22913 B.

Embankments.

On Saving and Stopping Slips. Showing the cause of landslips to be the presence of water; tracing the different ways in which it may attack a bank, and indicating the effective methods of preventing it by drainage. 2700 w. Ill. Ind & East Engr—Aug., 1898. No. 22687 D.

Freight Yard.

Harlem Transfer Co's. Freight Yard, New York City. Plan and data relating to this novel freight yard, designed by Walter C. Berg. 900 w. Ry & Engng Rev—Sept. 24, 1898. No. 23053.

Grade Crossings.

Abolition of the Grade Crossings on the Main Line of the Boston and Albany Railroad in Newton, Mass. I. History of the improvement, and an account of the street and drainage work connected therewith; by Irving T. Farnham. II. The depression of the railroad tracks; by William Parker. III. Bridges over the railroad tracks; by W. G. S Chamberlin. Ill. 11800 w. Jour Assn of Engng Soc—Aug., 1898. No. 22844 C.

Steam and Electric Railway Crossings. An editorial based upon the accident at Cohoes, N. Y., showing the importance of adequate mechanical protection, and suggesting an interlocking system, with derailing device for the electric line. 800 w. Ry & Eng Rev—Sept. 24, 1898. No. 23150.

Rails.

Advisability of Increasing Length of Rails and Advantages to be Derived from Use of Rails with Mitre-cut Ends. From a report by R. Caffrey, presented at the convention of the Roadmasters' Assn. of America. 2500 w. Ry & Engng Rev—Sept. 17, 1898. No. 22831.

The Danger of Using Too Hard Steel Rails. C. P. Sandberg. A paper before the Iron & Steel Institute showing the danger of fracture with too hard steel, especially in cold climates. 2000 w. Engr, Lond—Sept. 2, 1898. No. 22708 A.

R. R. Water Supply.

Locomotive Water Supply. Theodore W. Snow. Discusses tank fixtures, standpipes and track tanks. Also general discussion by Mr. Thomas Appleton. Ill. 2500 w. Jour of W Soc of Engs—Aug., 1898. No. 22794 D.

Reservoir.

A Storage Reservoir for a Railroad Water Station. Augustus Torrey. Describes a novel plan used in constructing a waste weir. 1000 w. Jour of W Soc of Engs—Aug., 1898. No. 22795 D.

Signal Poles.

Iron Signal Poles on the C. M. & St. P. Ry. Illustrated description. 1000 w. Am Eng & R R Jour—Sept., 1898. No. 22455 C.

Signals.

Improvements in French Block Systems (Neuerungen in Französischen Blocksysteme.) Oskar Walzel. A review of the improved signal system recently installed on the Northern Railway of France. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 19, 1898. No. 22912 B.

The Bouré System of Interlocking Signals. (Les Enclenchements par Serrures, Systeme Bouré). F. l'Heureux. Especially adapted to be used at small stations where a complete signal tower is not required. 5000 w. 3 plates. Revue Universelle des Mines—Aug., 1898. No. 22945 H.

Stations.

Great Railway Stations of England. Thomas Cargill. A very fully illustrated account of the principal railway terminals with plans of track arrangements, and details of design and construction of buildings. The first of a series of three papers. 4500 w. Engineering Magazine—October, 1898. No. 22997 B.

New Goods Station, Great Northern Railway, Manchester. Illustrated account of the new station, now under construction, with plans of the complete structure and photographs of the present condition of the works. 2000 w. Engr, Lond—Sept. 2, 1898. No. 22706 A.

The New Dresden Main Station. Illustrated description of a new building, said to be one of the finest of its kind in Europe. 1500 w. R R Gaz—Sept. 9, 1898. No. 22618.

Tie Plates.

Tie Plates. Extracts from an interesting report presented at the Denver convention of the Road Masters' Assn. of America. 2200 w. R R Gaz—Sept. 23, 1898. No. 22862.

Ties.

Tie Preservation in the Southwest. Information on the operation and development of the preservation plant at Somerville, Tex., with some of the results of the zinc-chloride process on ties laid thirteen years ago. Ill. 1100 w. Ry & Engng Rev—Sept. 10, 1898. No. 22827.

Track.

Track Construction. D. F. Carver. A paper before the N. Y. Street Railway Assn., giving the writer's views, especially as to substructure for street railway track. 2000 w. St Ry Rev—Sept. 15, 1898. No. 22861 C.

Track Construction in the Far East. Brief illustrated description of peculiar methods. 700 w. Ry & Engng Rev—Sept. 10, 1898. No. 22828.

TRAFFIC.

Rates.

Canadian Pacific Passenger Rate Differentials. Synopsis of the decision of the Interstate Commerce Commission, with editorial. 2800 w. Ry & Engng Rev—Sept. 10, 1898. No. 22829.

The Canadian Pacific Decision. Editorial upholding the soundness of the recent decision of the Interstate Commerce Commission. 800 w. Bradstreet's—Sept. 10, 1898. No. 22602.

The Reduction in Railway Transportation Rates in the United States. Editorial comment on a special report recently published by the Division of Statistics of the Dept. of Agriculture giving the decrease in railway passenger and freight rates, and the means by which this reduction has been brought about. 1800 w. Eng News—Sept. 1, 1898. No. 22462.

STREET AND ELECTRIC TRAMWAYS.

Accounting.

Report on Standard System of Street Railway Accounting. Report of the committee appointed at the Niagara Falls convention. 18,000 w. St Ry Rev—Sept. 15, 1898. No. 22855 C.

Accumulator Traction.

Present Position of Accumulator Traction. M. Van Loenen-Martinet. A report read at the meeting of the Permanent International Tramways Union, held at Geneva, upon the question: "What progress has been made in accumulator traction?" 1700 w. Ry Wld—Sept. 8, 1898. No. 22869 A.

Australian Tramway.

Tramway System of Brisbane, Australia. S. Herbert Brown. Gives an account of the change from the horse to the electric system, the extension of lines and the success met with. Ill. 1800 w. St Ry Jour—Sept., 1898. No. 22502 D.

Bahia.

The Electric Street Tramway in Bahia. (Die Elektrische Strassenbahn in Bahia.) Gustav Braun. An illustrated account of this Brazilian road, with map showing the route along the coast from Bahia to Itapagipe. 2000 w. Elektrotech Zeitschr—Sept. 8, 1898. No. 22979 B.

Bonds.

Rail Bonds. Calls attention to points learned by experience, and gives illustrated description of the mechanical features of many types. 4000 w. St Ry Jour—Sept., 1898. No. 22499 D.

Track Bonding. R. P. Brown and G. E. Chapin. Report of committee to the N. Y. State St. Ry. Assn., discussing the various kinds of rail bonds for electric return currents and comparing the independent bonds with the continuous welded rail. 2300 w. St Ry Rev—Sept. 15, 1898. No. 22859 C.

Boston Elevated.

The Harvard Power Station of the Boston Elevated Railway Company. H. W. Weller. Illustrated description of this new power house, including the present plant and the plans for future extension. 2500 w. Elec Engr, N. Y.—Sept. 8, 1898. No. 22754.

The Proposed New Electric Elevated Railway in Boston. Gives a brief description of the new elevated railway system as at present planned, with a statement of the difficulties of the problem. Ill. 1200 w. St Ry Jour—Sept., 1898. No. 22495 D.

Boston Street Railways.

Street Railway Conditions and Financial Results in Metropolitan Boston. Illustrated description of the principal investment, traffic and operating characteristics of thirty-nine street railways located in the city of Boston, and in about seventy-five suburban cities and towns in the immediate neighborhood. 13,800 w. St Ry Jour—Sept., 1898. No. 22493 D.

Boston Subway.

The Boston Subway. Brief history and illustrated description of this very successful engineering work, giving information concerning traffic, platforms and stations, construction and equipment, and cost. 5000 w. St Ry Jour—Sept., 1898. No. 22494 D.

Bradford.

Bradford Corporation Electric Tramways. An illustrated account of the plant recently installed at Bradford, England, noteworthy as being owned and operated by the municipality. 2000 w. Elec Engr, Lond—Aug. 26, 1898. No. 22773 A.

Budapest.

The Electric Underground Railway at Budapest. (Le Chemin de Fer Electrique Souterrain de Budapest.) P. Crépy. Description, with photographs of stations and views of the cars, trucks, boilers and engines. 2000 w. 1 plate. La Revue Technique—Aug 10, 1898. No. 22332 D.

By-Products.

By-Products of the Power House. M. M. Fenner. Read at meeting of the N. Y. State St. Ry. Assn. The writer's experience for four years in the utilization of exhaust steam. Discussion. 5000 w. St Ry Rev—Sept. 15, 1898. No. 22858 C.

Car Mileage.

Car Mileage—How Arrived at, and Its Use. A. H. Ford. Read before the St. Ry. Accountant's Assn. of America. Explains briefly its use and how arrived at, giving copies of some of the forms used. 500 w. St Ry Rev—Sept. 15, 1898. No. 22854 C.

Central Stations.

Central Station Economics. William D. Ennis. Part first discusses the operative economies of an electric railroad power station, especially considering the improvements in mechanical apparatus. 2700 w. R R Gaz—Sept. 2, 1898. Serial. 1st part. No. 22521.

Changed Power.

Conversion of the Edinburgh Horse Tramway System into Cable Traction. W. N. Colam. States the conditions under which these lines have been compelled to operate, and shows that though they are unfavorable the results have been very satisfactory. Gives reasons for adopting the cable system, and description. 5300 w. St Ry Jour—Sept., 1898. No. 22505 D.

Steam Railroad Conversion Near Lockport. Illustrates and describes the change made on a branch line of the Erie Railroad, running from Tonawanda to Lockport, N. Y. The service of a mixed type, the passenger traffic being carried on by trolley cars, and the freight service by electric locomotives. 3000 w. St Ry Jour—Sept., 1898. No. 22503 D.

Economy.

Economizing Electrical Power. E. G. Connette. Reports the improvement in consumption of power on the Nashville Street Railway since it has been running on the meter system, giving the rules issued and the suggestions for economical application of the current. 2000 w. St Ry Jour—Sept., 1898. No. 22497 D.

Electric Cars.

Equipment and Maintenance of Electric Cars. M. S. Hopkins. Read before the A. S. R. A. Gives the results of extended experience. 6800 w. St Ry Rev—Sept. 15, 1898. No. 22851 C.

Electric Construction.

Recent Electric Construction of the New York, New Haven & Hartford Railroad Company. N. H. Heft. A report of the recent extensions of this system, and the changes made in the rolling stock. Ill. 1600 w. St Ry Jour—Sept., 1898. No. 22504 D.

Electric Locomotive.

The Substitution of Electricity in Place of Steam on a Branch of the Erie R. R. Two 36 ton electric locomotives, of 640 h. p. each are used to haul freight and passenger traffic over 29 miles of track. The overhead trolley system is employed. 1200 w. Eng News—Sept. 8, 1898. No. 22726.

Electric Railway.

The Buffalo and Lockport Electric Railway. Illustrated description of this railway operated by Niagara power for both freight and passenger traffic. 1500 w. Elec Engr, N. Y.—Sept. 8, 1898. No. 22756.

English Tramways.

English Electric Railroads. A statement of the general situation in England with notes on a few of the roads recently completed. Ill. 2800 w. R R Gaz—Sept. 2, 1898. Serial. 1st part. No. 22522.

Inspection.

Herrick's Electric Car Inspection System. A complete portable testing set of instruments is provided, enabling systematic inspection to be carried out at any point on the line. 1500 w. Elec Engr, N. Y.—Sept. 8, 1898. No. 22755.

Inspection and Testing of Motors and Car Equipments by Street Railway Companies. Frederick B. Perkins. Read before the A. S. R.A. Discusses the care of electrical equipment and the system of inspection. 4500 w. St Ry Rev—Sept. 15, 1898. No. 22852 C.

Light Railways.

The North Sunderland Light Railway. Brief illustrated description. 1200 w. Transport—Aug. 26, 1898. No. 22593 A.

Mail Carrying.

The Carrying of U. S. Mail Matter on Interurban and Street Railways. W. S. Dimmock. Read before the A. S. R. A. Showing the gain to the Post Office Department from the use of electric lines. Discussion. 6300 w. St Ry Rev—Sept. 15, 1898. No. 22850 C.

Motive Power.

Possible Future Motive Power for Tramways. W. H. Booth. Discusses the possibility of using blast-furnace gases by putting down gas engines and dynamos, and manufacturing electricity. 2200 w. Ry Wld—Sept. 8, 1898. No. 22506 A.

Motor Truck.

New Motor Truck for the Lake Street Elevated, Chicago. Illustrates and describes a design by Frank Hedley. The construction is simple, with a large clear space for the motors. 400 w. R R Gaz—Sept. 16, 1898. No. 22821.

Norway.

The Holmenkollen Railway. (Die Holmenkollen-Bahn.) F. Hoffman. A very complete account of this electric road, running from Christiania to Holmenkollen, with map and many views, and plans of the wiring and station accumulators. 6000 w. Elektrotech Zeitschr—Sept. 1, 1898. No. 22974 B.

Paris.

Dual Electric System in Paris. A detailed description of this installation for dual or mixed traction, constructed by the French Thomson-Houston Co. Ill. 1700 w. Ry Wld—Sept. 8, 1898. No. 22867 A.

Power Consumption.

Power Consumption on Electric Railroads. S. T. Dodd. Read before the Civil Engs.' Club of Cleveland. Analyzes train resistances under the divisions of grade curve, acceleration and frictional resistances, and illustrates the data by problems. Also discussion. 5000 w. Jour Assn of Engng Soc's—Aug., 1898. No. 22845 C.

Power Cost.

Cost of Electric Power for Street Railways at the Switchboard, both Steam and Water Power. R. W. Conant. Read before the A. S. R. A. Facts and figures bearing on the operation of 44 power stations located at important centres throughout the United States are discussed. Discussion. 7500 w. St Ry Rev—Sept. 15, 1898. No. 22853 C.

Power Plant.

Long Distance Transmission Power Plant, Montpelier, Vt., with Battery Auxiliary. Illustrates and describes the new plant of the Barre-Montpelier Traction and Power Co., which presents some very interesting features. 500 w. St Ry Jour—Sept., 1898. No. 22501 D.

New Power Plant at Akron, Ohio. Illustrated detailed description of a first-class plant. 1500 w. St Ry Jour—Sept., 1898. No. 22500 D.

Power Stations.

Temporary Power Stations of the Metropolitan Street Railway Company. A description of the two substantial temporary power houses of the New York Metropolitan Railway, with illustrations of Switchboards and automatic stokers. 1800 w. Elec Wld—Sept. 10, 1898. No. 22764.

Rails.

Rails; Their Construction from a Scientific Standpoint. A. J. Moxham. Read at meeting of the N. Y. State St. Ry. Assn. Reports experiments conducted by the Lorain Steel Co., and the conclusions reached. 3300 w. St Ry Rev—Sept. 15, 1898. No. 22860 C.

Signal System.

Signal System for Single Track Roads. H. S. Cooper. Read at meeting of the N. Y. State St. Ry. Assn. Considers the characteristics of a reliable signal system. Discussion. 3500 w. St Ry Rev—Sept. 15, 1898. No. 22857 C.

Suggestions.

Some Suggestions to European Electric Railway Builders. Some points of importance regarding roadbed, track special work, power stations, equipment, &c. 1200 w. St Ry Jour—Sept., 1898. No. 22496 D.

Traction.

Electric Traction. Charles A. Carus-Wilson. A discussion of some of the principles connected with the application of the direct current motor to electric traction. Ill. 5000 w. Jour Soc of Arts—Sept. 16, 1898. Serial. 1st lecture. No. 23016 A.

Electric Traction on the Wannsee Railway. (Ueber die Elektrische Zugförderung auf der Wannseebahn.) A paper by Director Bork before the German Railway Society, with detail accounts of the operation of the section of road between Berlin and Zehlendorf by electricity. Data of construction, operation and cost for the past year are given. 6000 w. 1 plate. Glaser's Annalen—Aug. 15, 1898. No. 22920 D.

Heavy Electric Traction, Buffalo & Lockport Ry. Particulars of the most recent application of electricity to the steam railroad, in the United States, with illustrations. 2000 w. Ry & Engng Rev—Sept. 10, 1898. No. 22826.

Legal Aspects of Electric Street Traction in England. E. F. Vesey Knox. An exposition of the necessity for more extended use of electric traction in England, together with an account of the political difficulties which obstruct the efforts to meet the demand. 5000 w. Engineering Magazine—October, 1898. No. 22993 B.

Notes on Traction by Electric Power. A. C. Elliott. A paper setting forth the advantages of electric power for traction, and urging its wider extension to heavy traffic 2500 w. Elec Engr, Lond—Aug. 26, 1898. No. 22774 A.

Traffic.

Methods of Developing New Traffic on Street Railways H. M. Kennedy. Read at meeting of the N. Y. State St. Ry. Assn. Discusses some of the methods that have proved successful. General discussion. 7500 w. St Ry Rev—Sept. 15, 1898. No. 22586 C.

Tramway System.

Kingsland Electric Tramway System. Illustrates and describes an improved surface-rail system. 2000 w. Engng—Aug. 26, 1898. No. 22570 A.

Tramway.

The Blackpool and Fleetwood Electric Tramroad. Illustrated detailed description of the road and its equipment. 4000 w. Ry Wld—Sept. 8, 1898. No. 22866 A.

Transmission.

Air vs. Electricity in Long Distance Transmission. W. S. Norman. From British Columbia *Mining Record.* Aiming to show that for the uses of a mining camp, compressed air under the Taylor system is cheaper in its first cost of installation and much cheaper in operation in comparison with electric power. Ill. 4000 w. Compressed Air—Sept., 1898. No. 22492.

Truck.

A Passenger Locomotive Truck. Illustrates and describes a truck built by the J. G. Brill Co., of Phila., to carry an electric passenger locomotive which shall not only haul a train but carry passengers. 1800 w. Ry Wld—Sept. 8, 1898. No. 22868 A.

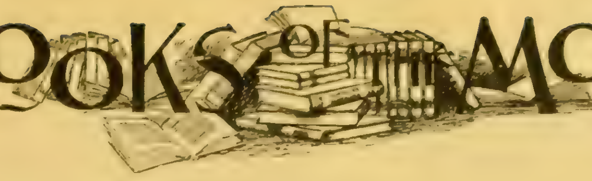
Comparative Earnings and Economy of Operation Between Single and Double Truck Cars for City Use. Richard McCulloch. Read at the Boston convention of the A. S. R. A. Gives comparison of power required and weights carried and shows the advantages and disadvantages of each type. With discussion. Ill. 5800 w. St Ry Rev—Sept. 15, 1898. No. 22849 C.

Underground.

Arrangement of Underground Electric Tramways. (Dispositif Electrique Souterrain pour la Traction des Tramways.) Ch. Gruet. Describes an improved underground trolley system on the separate contact principle. 2000 w. La Revue Technique—Sept. 10, 1898. No. 22939.

The Construction of Electric Tramways with Underground Conduits. (Construction des Lignes de Tramways Electrique à Caniveau Souterrain.) A general discussion of the constructive features of the problem, with sections of various forms of conduits for underground trolleys. 2500 w. L'Electricien—Aug, 6, 1898. No. 22963 B.

BOOKS OF THE MONTH



A Laboratory Guide in Qualitative Chemical Analysis, by H. L. Wells, M. A. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

Prof. Wells, who lately brought out a new authorized translation of Fresenius, now presents a method of teaching widely different from the one which, under the influence of the great German master, has become practically stereotyped in most schools of chemical instruction. The analytical methods of Fresenius still form the basis, with some commendable modifications and additions; it is in the manner of bringing the reactions to the students' notice, however, that the originality of the work is most striking.

The method adopted is essentially experimental; instead of taking up one radical at a time, describing its reactions with various reagents, and then having the student make confirmatory tests—a procedure which too often results in perfunctory work and induces a disposition to take the thing for granted, or be satisfied with a very imperfect reaction—the pupil works from the start with radicals whose identity has been purposely concealed; his attention is concentrated upon the conditions of his manipulation and the expectancy of an unforetold result. Then, by repetition of the same processes upon a series of labelled solutions, he is led to identify the unknown by its exact conformity in behavior with one of the known radicals. The natural result is a sustained interest, a rapid introduction into habits of exact manipulation and careful attainment of proper conditions for each reaction, and the collateral acquirement of many facts concerning other radicals, and especially the comparative conduct of different members of each group with each reagent.

The method seems somewhat laborious, but undoubtedly would prove quite the reverse when measured against the proficiency attained; not the least excellent feature is the gradual preparation of the student for the exact manipulations of quantitative analysis—a feature too often ignored in the qualitative laboratory.

The order of the work is logical and the review features excellent; in fact, it is, to a great extent, an application of the inductive system which proves so efficient in other departments of educational work. The chapter on ionization and ions is of doubtful value; the effort to condense has made it too abstruse for the average chemical student, at least at that stage of his education. The binding in of several sheets of perforated labels is distinctly an undesirable feature, as their removal will infallibly injure the binding. It is to be hoped this will be omitted in the later editions which the work well deserves, for as a whole it is excellent and to be strongly recommended to the attention of every instructor and student.

Machinists' and Engineers' Pocket Manual. Edited by D. B. Dixon. Chicago: Laird & Lee. 1898.

It is inevitable that a book will be judged more by what it lacks, if it lacks much, than by what it contains; and it is unfortunately true that this book, by attempting too much, too wide a range, has destroyed its chance for usefulness.

The first 124 pages are devoted to a dictionary of about 2000 mechanical and electrical terms, in which "Abscissa of rectilinear co-ordinates" is defined but "co-ordinates," "rectilinear," "axis" and others of the equally important and abstruse meanings which are indissolubly associated with abscissas, are ignored, a fault which runs through the whole book. But this, bad as it is, is not so bad as some of the definitions. For instance "Volt"—The practical unit of electrical pressure, etc." Is it not a theoretical unit also? "Indicator, Automatic — Any automatic device for electrically indicating, etc." Why necessarily "electrically"? Why make the compilation at all if it does not and cannot fulfill the functions of a dictionary? What then is its use? The only answer to these questions seems to be, "To sell."

There is a table of squares, cubes and their roots up to 1595; tables of weights of flat, round and square iron (but none of copper, brass or aluminum), and, besides still others, a table of hyperbolic logarithms. A series of questions and answers for the examination of stationary engineers; some matter on gear and screw-cutting, refrigerating machinery and the taking of indicator cards are the most important of the other subjects touched upon.

PRELIMINARY SURVEY AND ESTIMATES, by Theodore Graham Gribble, C. E. Text-Books of Science series. Second edition. London, New York and Bombay: Longmans, Green & Co.

We conceive that there is no more just way of introducing an author to his public than to let him speak for himself wherever it is possible, and we therefore extract from Mr. Gribble's introduction a few sentences which seem to us the key-note of his work.

"The American is just an Anglo-Saxon like ourselves, only with a little more liberty and a great deal more scope. He is not at all ashamed to come and learn from the old country what age and experience have qualified her to teach. . . . In simplicity of survey practice, uniformity of gauge, types of bridges and of rolling stock, the American engineer may be profitably (though not slavishly) imitated in the work of opening out a new sphere of enterprise. . . . The methods of surveying considered in the following pages are by no means exclusively American. In the class of work formerly called telemetry, but now tacheometry, we have to go to Italians, French and Germans for most of the original conceptions and the best modern developments."

In these days of tribulation when "alliance of English-speaking races," "commercial union," "community of interests," and other comforting sentiments seem to be in every English-speaking mouth on both sides of the Atlantic, it is gratifying to an American engineer to find that he is at last understood by his practicioner-germane.

The claim to eclecticism which is made in the previously quoted paragraphs is justified by the contents of the book, for it is a treatise, at once so clear, so scholarly and so discriminating that, with Wellington's "Theory of the Location of Railways," it may properly be said to cover the whole range of railway work up to the commencement of construction.

Nor is it confined to this, as will be seen by reading the chapter-headings which follow: General Considerations, principally devoted to railways. Route-Surveying or Reconnaissance. Hydrography and Hydraulics. Geodetic Astronomy. Tacheometry. Chain-Surveying. Curve-Ranging with Transit and Chain. Graphic Calculation for Preliminary Estimates, in which the application of the slide-rule to railway work is demonstrated. In the chapter on Instruments, Mr. Gribble gives the best dissertation on their construction and use that it has ever been our fortune to read. Not the least valuable feature of this part is a description of the tacheometer theodolite built after his own design.

A chapter entitled Parliamentary Work has only an academic interest for American engineers, since it deals principally with the requirements of Parliament relating to railways and other public works. The Resurvey of Railways, an Appendix (consisting mostly of tables and mathematics), a Glossary, some suggestions as to Light Railways for the Cape of Good Hope and an Index, complete this unusually satisfactory book.

BOOKS RECEIVED.

Practice and Theory of the Injector. By Strickland L. Kneass, C. E. Second Edition, Revised and Enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

Thermodynamics of the Steam Engine and other Heat Engines. By Cecil H. Peabody. Fourth edition, rewritten and reset. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1898.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Westinghouse Electric and Manufacturing Co., Pittsburg, Pa., U. S. A.=Catalogues (*a*) Electric Street Railway History; (*b*) Quarter of a Million Horse Power of Polyphase Electric Transmission Apparatus; (*c*) Polyphase Inductor Generators; (*d*) Generators and Rotary Transformers for Electrolytic Work. All are very handsomely illustrated and printed.

Garvin Machine Co., New York.=Illustrated catalogue of machine tools, including milling machines, screw machines, tapping machines, drill presses, and gear cutters, with many auxiliary tools, cutters, &c., together with cable code words for each article.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.=Record of recent construction, No. 7. Pamphlet containing illustrations and specifications of locomotives built for use in the United States, Brazil, Hawaii, and Mexico.

Consolidated Safety Valve Co, New York.=Revised and enlarged catalogue of "Pop" safety valves of various types, water relief valves, and mufflers.

C. W. Hunt Company, New York.=Illustrated catalogues (*a*) of mast fittings, coal tubs, hoisting blocks, and wheelbarrows; (*b*) of industrial railways for manufacturing establishments; and (*c*) of Manila rope for transmission and hoisting. These catalogues all contain much general information of value to the engineer and manufacturer, in addition to the presentation of the various articles.

Joseph Dixon Crucible Co., Jersey City, N. J., U. S. A.=Helps in brazing, being a description of the new dipping method of brazing bicycle frames and similar articles by the aid of the Dixon brazing crucible, brazing graphite, and anti-flux.

The New Britain Machine Company, New Britain, Conn., U. S. A.=Catalogues (*a*) of case steam engines; (*b*) of chain saw mortisers. Both catalogues are very complete and exhibit important and successful products in an excellent style.

The Williams Gauge Co., Pittsburg, Pa., U. S. A.=Illustrated pamphlet descriptive of the Williams safety steam boiler governor, a device for regulating and controlling the water level; also of the Williams pump governor and pressure regulator

Whiting Foundry Equipment Co., Harvey, Ill., U. S. A.=General catalogue of cranes, elevators, cupolas, ladles, trucks, tumblers and general foundry supplies.

The Wm. Powell Co., Cincinnati, Ohio, U. S. A.=Pocket edition of general catalogue of steam brass goods, including valves, lubricators, sight-feed oilers, water-gauges and cocks, and general brass goods for use with steam.

Lincoln Iron Works, Rutland, Vermont, U. S. A.=Illustrated pamphlet of stone sawing machines, both gang and circular, adapted for cutting hard or soft stone.

The Burt Manufacturing Co., Akron, Ohio, U. S. A.=Pamphlet illustrating the Cross oil filter for cleaning and recovering lubricating oil in manufacturing establishments to permit its repeated use.

Macleod and Clark, Cincinnati, Ohio, U. S. A.=Catalogue of the Buckeye light for contractors' and foundry use, also illustrating and describing Buckeye kerosene rivet-heaters and forges, contractors' hand pumps, paint-spraying machines, pulsating pumps, and steam traps.

International Correspondence Schools, Scranton, Pa., U. S. A.=Pamphlet giving a full synopsis of the course in telephony, as taught by correspondence, together with a general description of the character and importance of the subject, method of teaching, and vocations in which such knowledge would be of value.

W. W. Lawrence & Company, Pittsburg, Pa., and Buffalo, N. Y., U. S. A.=Pamphlet discussing protective coatings for iron and steel and setting forth the proper uses of Lawrence permanent paint No. 2050, and Lawrence asphaltic bridge conservative No. 1033.

Sullivan Machinery Company, Chicago, Ill., U. S. A.=Catalogue No. 32, containing illustrations and descriptions of Sullivan mining machinery, including shearing and undercutting machines for coal mining as well as rock drills, and diamond drills.

John A. Roebling's Sons Company, Trenton, N. J., U. S. A.=Handsomely illustrated catalogue of the Roebling system of fireproof construction giving details of its application to different portions of a structure, together with illustrations of numerous buildings to which the system has been applied; also pamphlet reprint of an essay on fire-proof construction by A. L. A. Himmelwright, C. E., discussing the general conditions of fire-proofing as required for the modern tall building.

Edward Smith & Company, New York.=Handsomely bound treatise on the use of painting to prevent corrosion, written by A. H. Sabin, M. S., giving much useful information as to protective coatings for structural metal work.

Roe Stephens Mfg. Co., Detroit, Mich., U. S. A.=Illustrated catalogue and price list of valves, including gate valves, swing checks, pop safety valves, globe, angle, and radiator valves, fire hydrants and water gate. Especial attention is directed to Scott's extreme high-pressure gate valves.

James Spencer and Co., Hollenwood, Manchester, England.=(*a*) Thirty-seven sheets illustrating, pricing, and describing with weights and dimensions nearly one hundred types of machine tools; (*b*) large poster illustrating the standard types of machine tools; (*c*) list of firms using Spencer's travelling cranes.

United States Metallic Packing Co., Ltd., Soho Works, Bradford, England.=Descriptive pamphlets; (*a*) self-adjusting metallic packing, 14 pages being devoted to its application to locomotive, marine, and stationary engines, and 120 pages to testimonials from users; (*b*) a list of users classified in districts, and showing the number of packings in use; (*c*) the Bradford portable power drill and reamer, with illustrations showing the drill in use.

Robert Stephenson & Co., Ltd., Newcastle-on-Tyne.=(*a*) Pocket-size catalogue of the Rocket oil engine with illustrations, testimonials, tests and other data; (*b*) leaflets giving list of users for pumping and other purposes.

Jas. B. Petter & Sons, Nautilus Works, Yeovil, England.=(*a*) Price-list containing data regarding the Petter petroleum engine, for which a very high degree of economy is claimed; (*b*) fully illustrated six-page catalogue of the "Nautilus Grate."

Holden & Brooke, Ltd., Manchester, England. =Price-list of "anti-primer" steam dryers and purifiers, with excellent cuts and sectional views; also a series of outline drawing showing the application of the dryer to various types of engines.

William Rose & Co., Metropolitan Works, Manchester, England.=(*a*) History of the fire service and its organization, with a description of the manufacture of fire engines, fire escapes, and hose, comprising in all 24 large pages of interesting facts; (*b*) catalogue of steam fire engines with full page illustrations, prices, and specifications; (*c*) 90-page catalogue of miscellaneous fire engines, escapes, hose and implement vans, chemical extincteurs, etc. Very fully illustrated, prices and full information being invariably given.

E. F. Jarvis, Middlesboro, England.=Catalogue "C" of Klein's patent water re-cooler and condensers, containing 20 pages of purely descriptive reading matter and illustrations; also several loose sheets with half-tone views of the various plants in the neighborhood of Middlesboro.

The Cycle Components Mfg. Co., Ltd., Bournbrook, Birmingham, England.=Leaflet describing the "C C" inflator.

The London Emery Works Co., 10 Vine St. Clerkenwell, London.=(*a*) Fully-illustrated 170-page catalogue of emery-grinding and polishing machinery, divided into two parts, the first describing and pricing emery wheels and other requisites, the second being devoted to a great variety of machines for grinding, with dimensions and prices; (*b*) thirteen leaflets of machines not described in catalogue, principally for tool grinding. (*c*) Folder giving prices and particulars of emery cloth, knife polish, glass and flint cloths, with samples.

John M. Rogers, Boat Gauge and Drill Works, Gloucester City, N. J., U. S. A.=Catalogue of measuring instruments of precision, shell, blade, and taper reamers. Dimensions and prices accompany the illustration of each tool. A full account of the Eureka Rock drill made by this firm is given.

Richard Ranken, 22 Manchester St., Liverpool, England.=Seven leaflets giving descriptions and illustrations of high speed horizontal and triple-expansion engines, barring engines, valves, clutches, and other specialties. In general, sizes, weight, and prices are not given.

Cosens & Co., Ltd., Commercial Road, Weymouth, London, E.=Monthly sale-list of engineers' supplies and machinery.

Blackstone & Co., Ltd., Stamford, England.= (*a*) Leaflet with illustration and prices of the Blackstone gas engine; (*b*) four page price-list of the Blackstone oil engine, with dimensions and testimonials.

B. & S. Massey, Openshaw, Manchester, England.=Catalogue of steam hammers, stamping, and forging machines, with dimensions, weights and code words for each machine; the illustrations are well printed and tinted.

Tolch & Co., Boat Yard, Fulham, London.= Catalogue of oil engines and oil launches, with weights, over-all dimensions, and prices; also details of the Tolch reversible propeller.

The Trusty Engine Works, Cheltenham, England.=Well printed catalogue of the Trusty oil engine, with illustrations of several types, both stationary and portable, and the usual data as to prices, weights, and dimensions and also the space occupied by the shipping cases.

Ralph Horsfield & Co., Chapel-en-le-Frith, England.=Excellently designed half-tone photo book of a great variety of steam engines, combined engine and vertical boiler plants, and hauling engines, accompanied by a separate short account of their general lines of manufacture.

Phœnix Dynamo Co., Bradford, Yorkshire, England.=Illustrated price-list of continuous-current dynamos and motors, with useful information on general electrical problems.

Littlejohn & Service, Johnstone, Glasgow, Scotland.=Well-printed and illustrated catalogue of all kinds of cranes, shipbuilders' and boilermakers' machine tools. In many cases, prices and full information are given. The machines illustrated are bending rolls, steam hammers, punching, and shearing machines.

Tilghmans Patent Sand-Blast Co., Broadheath, Manchester, England.=(*a*) Catalogue of sand-blast machinery, including a full account of the use to which the sand blast is put, and prices and particulars of air compressors, boilers and other machinery; (*b*) smaller list containing the same information condensed.

Fletcher Russell & Co., Ltd., Warrington, England.=Catalogue of laboratory and furnace appliances, handsomely-illustrated and printed, with testimonials from users. The prices and sizes relate to the muffle furnaces, burners, ovens, etc., with which the catalogue principally deals.

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CHINESE RAILROAD DEVELOPMENT, PAST, PRESENT, AND FUTURE.

By Charles Denby and E. P. Allen.

THE main interest of China at the present time in the eyes of the engineering world is as a field for railroad enterprise. Twenty-two years have elapsed since the first effort by ocular demonstration to convince China of the value of railroads. The effort succeeded only too well for official peace of mind. The conservative objections to the introduction of railways have been many and various. The principal opposition was from the censors, who affect to reflect popular opinion, and who claimed that the construction of railroads would cause desecration of the graves of the dead, and that their operation would throw myriads of laborers out of employment, and from the board of revenue, which maintained that railroad traffic would render impossible the collection of the *likin* tax, which is a species of *octroi*. But there was also a Chinese Ruskin, who protested against the defacement of China's fair land "with the gridiron of railroads that makes the western countries hideous," and he was perhaps the only genuine objector of them all. The much-talked-of popular outcry against railroads was all in the ear of the official class, and, where it really exists, no doubt owes its existence largely to official incitation. As to the *likin* tax, the mandarins did not stop to consider the willingness with which even native merchants would see that oppressive and trade-choking system abolished, and refused to admit that a change is not necessarily to be condemned because it brings other changes in its train, but held out strenuously for the *likin* simply because it gave them unlimited opportunities for peculation.

These objections came, and still come, principally from the provincial authorities. The provincial isolation, which makes it possi-

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ble for a viceroy to set himself up as a semi-independent sovereign, and leaves even lesser officials without any strict accountability, is the bane of China. If the Chinese did but know it, railroads, with the freedom of intercommunication which they establish, will be their salvation as a nation; and it matters not whether the railroads are built and controlled by them or by foreigners. When by their means the Chinese come to know themselves, they, with their industry, tenacity, and numbers, will become a power which no European nation can keep in partition and under effective control. And there have been and are some among the statesmen of China who have realized this truth and made a vigorous fight for reform. In his dying memorial to the throne the once distinguished viceroy of Nanking, Tso-Tsung-t'ang, said in 1885: "Railroads must be built. In foreign countries railroads are built by merchants, but military movements are facilitated by them. Transportation is facilitated and made expeditious, and, wherever the railroads extend, there benefits accrue. Before the railroads were made, many hindrances were thrown in their path, but, when once they came into existence, the people on that account grew rich, the countries more powerful, and goods imported were multiplied. That there is every advantage and no detriment is only too obvious. The comments of the masses are multifarious, but there is no necessity to argue with them and explain everything. As the Analects have it, 'the people may be made to follow, but cannot be convinced.' Take, for instance, the telegraph and steam navigation, things China never had before; yet, once they are initiated, they become indispensable. If railways are introduced, the benefits that will be derived are of still wider scope."

Who could say more? It is strange that so strong and direct an appeal penetrates so little the petrified conservative brain.

Marquis Tseng, one of the most able of China's statesmen, who suffered the penalty of dowager-imperial displeasure and of death for his outspoken and active campaign of reform, once sadly wrote: "[China] has failed to see that the old familiar paths, which many centuries had made dear to her, did not conduct to the goal to which the world was marching." It is a thought which calls for sympathetic pause even in this headlong western world.

The first railroad constructed in China was a narrow-gauge line from Shanghai to Woosung, put down in 1876, and intended chiefly as an ocular demonstration to the Chinese. The enterprise was initiated by Jardine, Matheson & Co., a British house in the Chinese trade, which is now again to the fore in a far more important undertaking. The contractors of this first railway were English, and one of them was the Mr. John Dunn whose name is principally connected with the Cleopatra Needle, and who is still engaged in engineering work in the east. The engineer was Mr. G. J. Morrison. In the fall of 1876 the whole line of ten miles was opened to the public. At the end of twelve months it was sold to a Chinese official, who straightway tore up the rails and deported them to Formosa. The single dummy engine of the line now reposes peacefully in the mud of some Formosan harbor, together with the wreck of the junk in which it was transported. During these twelve months of its existence the Shanghai-Woosung railroad, with its single dummy engine and its train of small cars, which, by the way, were of the American pattern, carried three hundred thousand passengers. The Chinese came from far and wide to see and experiment with this new barbarian curiosity, and the people in the neighborhood, soon finding it an institution of great practical utility, became regular patrons. The predicted uprising of the people against the construction of the road never materialized, and, as for the graves along the route, Mr. Morrison himself is authority for the statement that every farmer would manufacture as many graves as he could get dollars for permission to traverse them. In justice to the Chinese, however, it must be explained that their action in taking up the Shanghai-Woosung railway was not without cause from the point of view of strict legal and diplomatic right. As is well known, aliens can have no rights in real property outside of treaty ports in China, except by special governmental grant. There was no grant in this case, and the construction of the railway was a stolen march, characterized, indeed, by Sir Thomas Wade, British Minister at the time, as an outrage, although there is reason to believe that the promoters were aided and abetted by the local Shanghai officials. The Chinese government demanded the abandonment of the road, and the sale was, in fact, the result of diplomatic arrangement. Upon acquiring the road it was torn up and deported by way of reassertion of injured governmental dignity.

The next railroad undertaking in China began on an even smaller scale, but it was permanent, and grew to large proportions. About the time the Shanghai-Woosung railroad had ended its short lease of life, Mr. C. W. Kinder, the engineer of the Kaiping coal mines, which were worked with private capital, constructed a tram-line for moving his coal. He was most resourceful with his limited facilities, and succeeded in transforming an old traction engine into his first locomotive. Later he built a more acceptable engine, principally out of material on hand in the shops of the company at Tongshan. From these small beginnings have sprung the very considerable railroad property of the China Railway Company, from Kaiping to Tonku, across the Peiho river from Taku, a distance of some eighty miles.

This road was completed and opened to general traffic about 1886. Mr. Kinder's resources were extremely limited, and the construction of this road was therefore none of the finest, but it was due only to his indefatigable energy that anything was accomplished at all. The fact that he was able to grasp and utilize his opportunity and to complete a railroad with Chinese capital, and under the eyes almost of the government at Peking, has no doubt advanced the railroad era in China by many years. It is at Tonku that the Kaiping coal is loaded on steamers for Shanghai and other southern ports.

In 1886 the government took a new departure, and itself determined to construct a railroad. The outcome of this determination is the line from near Peking to Tientsin, thence to Taku, and thence, utilizing the Kaiping-Tongku line, to Kaiping, and onward to Shanghai-Kwan,—a total distance of some two hundred miles. This line is now being extended beyond the great wall, and will ultimately reach Newchwang. The Peking terminus is four miles from the city, and connection is to be made by an electric line, the contract for the construction of which has been taken by the German Siemens-Halske Electric Company. The engineer of the railroad is Mr. Kinder, and up to last year the chief Chinese manager was Ng Choy, a man of marked ability, a member of the British bar, and now minister at Washington, known to us as Wu Ting-fang. The portion of the road from Taku to Tientsin was opened in 1889, and none too soon, for the Peiho had become so blocked with detritus that no steamer could enter so far as Tientsin, which is the great commercial gate of Northern China and Shanghai's nearest competitor in the trade of the empire. At the present time no steamers go above Tongku, which is a few miles below Taku, and on the opposite side of the river. The great value of this line for commercial purposes did much to convert the Chinese mind to an acceptance of railroads.

The equipment of the imperial system is of varied character, but, on the whole, it follows American patterns, particularly in the matter of the cars, which are built at the Tongshan works. The first train started out with Janney couplers and Westinghouse air-brakes, the latter a present from the patentees to the government. The road is ballasted with stone, and the ties are principally of hard Japanese wood. Lately American ties have also been imported from the Pacific coast. The permanent work is iron, steel, or stone masonry, to suit climatic conditions of extreme heat and cold. The road-bed is raised, with the necessary flood-openings. The gauge is standard.

The most important railroad undertakings of the near future in China are the projected lines from Hankow to Canton. The concession for the northern line has been granted to a Belgian syndicate, which is alleged to be a stalking-horse for Russian interests. The fact that 75 per cent. of the trade of Hankow is in the hands of Russians lends color to this belief. The concession itself has been subjected to serious criticism, on account of the unfavorable terms to its holders, and the Belgians are thought to have been rather too precipitate in their endeavor to get ahead of rival syndicates; but, if it is really Russian interest behind the syndicate,—which, however, is denied by Russia,—Russia may be counted upon to secure modifications when they become desirable. The Russian bear has a certain gentle insistence, before which it is very hard for even a Chinaman to remain immovable. The construction of the Belgian syndicate is to be known as the Luhan road. About thirty miles of it at the Peking end have been completed, and the road-bed has been laid as far as Pao-Ting fu. Eight Rogers Mogul engines recently arrived near the scene of operations, and are awaiting the completion of additional road before being put in service. The work is now awaiting the arrival of rails from the Han Yan works at Hankow, which were established by Chang Chih-tung when a Peking Hankow road was first contemplated some years ago, he being furnished with an imperial rescript to proceed with its construction. The rails rolled at the Han Yan works are said to be of inferior quality, and it is doubtful if they will be utilized. The pig iron is made at the same works, and the coke employed for this purpose is brought partly from Tongshan, but partly, at a cost which may be imagined, from Europe. In this case, at least, China's desire to depend upon her own resources is costing her a pretty penny. But she may live to find that her experience was not too dearly bought. A commencement has to be made; not long ago steel rails in the United States sold for more than $100 per ton.

The total distance from Peking to Canton is from 1,400 to 1,500 miles, and Hankow is about half-way between. The only serious engineering obstacle to be surmounted in the northern half is the Yellow river, with its ever-shifting bed. The bed of the stream, in its lower reaches, is some fifteen feet above the surrounding country. The river, because of its frequent disastrous overflows, by which sometimes thousands of villages are destroyed, and tens of thousands of helpless natives drowned or rendered homeless and ruined, has long been known as "China's Sorrow." The first record of an engineering attempt to prevent the overflow was in B. C. 2293; for more than four thousand years China has sacrificed her life and wealth to this insatiable monster. The successful solution of the problem of the Yellow river is an accomplishment which might well satisfy the most ambitious of our engineers. Perhaps the necessities of the Lu Han railroad will bring to bear the requisite attention and effort. But whether the necessary capital could be provided in any near future is more than doubtful. In the meantime an American engineer, Mr. Rich, is recommending a ferry as a temporary solution of the difficulty.

The concession for the construction of the southern road from Hankow to Canton has been granted within the last few months to an American syndicate headed by Senator Calvin S. Brice. This syndicate will spend $100,000 in preliminary work, and, on the signing of the contracts in Washington, made a deposit of that amount as an evidence of good faith. It is taking time by the forelock, and its engineer, Mr. W. Barclay Parsons, of New York, is already on his way to the field of operations. The estimated cost of the road is $40,000,000. The bulk of the material used will probably be American.

A British syndicate, headed again by Jardine, Matheson & Co., is undertaking the construction of a railway from Shanghai into the interior, which is of the greatest commercial importance. The road will run from Shanghai through Soochow, eighty-five miles inland, thence to Chinkiang, one hundred and twenty miles up the Yangtze at the entrance to the Grand Canal, and thence to its terminus at Nanking, the viceregal capital of Kiangsu. The province of Kiangsu, traversed by this road, has a population of some forty millions, and the cities on the route of the road are among the most important commercial centers of the empire. The little road which has again been built between Shanghai and Woosung, this time of standard gauge, was opened on September 12 of this year, and will one day be merged in the Shanghai, Soochow, Chinkiang, Nanking line.

When a longitudinal trunk-line in China was first discussed, several routes were considered. The government settled its preference on a line from Peking through Hankow to Canton, alleging as reason therefor that, in time of war, it would be safer from attack than a line nearer the sea. That reason may be cogent enough for its purpose, but from a commercial point of view it surely seems that the best longitudinal line would be one constructed from Peking southward along the route of the Grand Canal, which should connect with the great Shanghai-Nanking line at Chinkiang and go on to Hangchow, which is the southern terminus of the Canal, and an important trading center of some four hundred thousand inhabitants. In the words of Mr. Colquhoun, "such a line would pass some forty towns with an average population of twenty-five thousand each, and a large number of villages. The length of the Grand Canal from Tientsin to Hangchow is six hundred and fifty miles. No better line exists in the world, from the point of view of population, resources, and cheapness of construction. It follows the most important of the actual routes of commerce in the empire, passes the greatest possible number of cities, towns, and villages, and connects great ports with rich coal regions of established value."

In connection with a proposed line on the grand canal route an interesting case recently arose. Yung Wing is a Chinese subject well known in the United States. He had charge of the Chinese students who, about twenty years ago, were sent to America to be educated. His residence is Hartford, Connecticut, where he married and raised a family. He was naturalized in 1852, and has voted at every election since that time. He is the bearer of several passports issued by the secretaries of State. Recently he went to China to secure a railroad concession. He was granted the right to build a line from Tientsin to Chinkiang. As Chinkiang is about one hundred and thirty miles from Shanghai, the road from Tientsin to that place will be a strong competitor with the Peking-Hankow line. Hankow is six hundred miles up the Yangtze, and Shanghai is at its mouth. In doing the business between the great port of China and the north, the Chinkiang line, being shorter than any other, would have the preference. Chang Chih-Tung, who was interested in the line from Hankow to Peking, for these reasons protested against the granting of this concession to Yung Wing, but a greater power than Chang Chih-tung entered the lists.

The German minister protested that, under the convention between China and Germany, China had no right to grant to the citizens of any country but Germany the right to construct a railroad through Shantung, and he demanded the annulment of the right granted to Yung Wing. The Yamen meekly obeyed, and advised Yung Wing to make terms with the German minister. Yung Wing appealed to what he thought was his own country, but was advised that the State department did not recognize that any Chinaman, either before or after the act of 1882, could be naturalized in the United States, and, as he was not a naturalized citizen, the government could not intervene in his behalf. It is reported that Yung Wing followed the advice of the Yamen, and has made an arrangement with German subjects to build the road.

This case came near raising the important question as to what action the United States would take if China were to carry out the German view of granting to one country alone the right to construct railways in any province. The favored-nation clause in all the treaties provides that all the rights and privileges granted to the most favored nation shall be granted to the nation with which a treaty is made. There can be little doubt that a decree by China that the citizens, or subjects, of one nation should have the exclusive right to build all the railroads in China would be resisted by the European powers. It seems that the same principle ought to govern with regard to each of the provinces of China. Anxious as England is to avoid war, public sentiment would force her to fight over the assertion of an exclusive right by any nation to build railroads and operate mines in any province, provided an Englishman had demanded such a right, and had been refused. She will, probably, take care that no such case shall arise, and thus avoid trouble.

The fact that British enterprise is not contenting itself with the Yangtze valley limits, which other nations seek to assign to it, was referred to in the last number of THE ENGINEERING MAGAZINE. The immense mineral concessions of Shansi are the richest prize that has fallen to any syndicate, and the Peking syndicate which has obtained them is principally British in its make-up. These mineral concessions carry with them the right to construct railroads in order to open access to the ore beds and for general traffic. The coast-side outlet of the region will, presumably, be Tientsin, and the road doubtless will take in the capital also, on its way to the west. The right of the Peking syndicate to continue its lines of railway through Shansin and beyond the borders of Honan has been but lately recognized. Since neither Shansin nor Honan contains any treaty port, and since the Peking syndicate will hardly wish to depend solely on the Belgian (Russian?) Luhan road for a southern outlet, its ultimate aim doubtless will be to reach the Yangtze on its own account, as has recently been surmised by the London *Times.*

Another British syndicate has been granted the right to construct a railroad from Kowlung to Canton, thus connecting this most populous of Chinese cities with a British possession on the coast. And in the southwest a road is being built from Mandalay, in Burma, to a point in the Salwen river close to the southwest corner of Yünnan,—a distance of two hundred and fifty miles. In due course this road will be pushed on through that rich province, once the most secluded in China. There are engineering difficulties in Yünnan, however, which make that enterprise less attractive than many another.

The Germans are talking of building a railroad inland from Kiao Chou, but no details of their plans are settled. Meantime the French concession for a line from Tonking toward Canton does not seem to be pushed. The London *Times* suggests that the Frenchmen "are satisfied with the diplomatic success of procuring the concession, and seem to have no immediate purpose of following it up by the less agreeable process of finding capital." The above is a full statement of completed and projected railroads in China proper, and in the empire as well, except the lines in Manchuria, which are to connect with, and really form a part of, the Russian Siberian system. These lines are not Chinese, despite the association of emblems in the flag of the so-called Chinese Eastern Railway, and in any event they have been so often described of late as to be well known.

As this article is being prepared for publication, serious and conflicting news comes from China. The emperor's deposition and his death have been reported, and the disorganization of the empire, and its consequent partition, are predicted.

Capital will look seriously into these questions before any investment is made in China. It is, therefore, proper that the writers of this article, who have had some experience in Chinese matters, should give their opinion as to the probable permanence of the Chinese government.

There is not much probability of a partition of China. Germany, Russia, France, and England have seized what they want of the territory of China. They recognize that she is the greatest market on earth for their manufactured goods, and the greatest field for industrial enterprise. They have no interest in dividing her up into hostile camps, in checking production, and paralyzing progress. The more the Chinaman is civilized, the greater purchaser of imported goods he becomes. If every man in China wore a shirt, the sale of shirtings would keep all the mills in the United States busy; and so with other articles. Missionaries and commercial agents are teaching them to wear shirts. With sound plausibility the continental nations could demand a concession to enable them to establish coaling depots. In these days of steam such places are necessities for warlike, as well as commercial, purposes. To seize the interior would be wanton spoliation, and would accomplish no good purpose.

Nations are governed by self-interest. It is the interest of the world to preserve the autonomy of China. It is particularly to American interest to do so. To carry out this view the United States need only hold the Philippines, which they claim as their own by conquest. Holding these valuable islands, they do not need to take any part of the mainland of China.

If the question of partition is disposed of, there remains the danger of popular revolution, which might result in splitting China up into several parts, each under a separate government. In the opinion of the writers there is no such danger ahead for China. Let it be remembered that the history of China dates back six thousand years, and that during all the time her government has controlled, and taken care of, one-fifth of the population of the world. Let it be recognized that the Chinese have been reasonably well clothed and fed and governed. As much happiness and contentment prevail in China as anywhere in the world, except our own land. The world knows that the attachment of the Chinese to their home is phenomenal. Could such attachment exist, if their home was not a happy one? The Chinese people are not patriotic in the western sense, but they love the land, the country, the family, as no other people in this world do. They are eminently peaceful. They abhor disorder. They do not talk politics. They have had attempted revolutions and intestine wars,—mostly on real or supposed religious questions,—but all nations have had such experiences.

It must be said, also, that at this hour China is in the hands of a strong, intelligent, and revered woman—the empress dowager. She is one of the historic characters of the world. She ruled China for thirty years during the most difficult period of its history,—the period when foreign plans and methods were being introduced, and new ideas, thoughts, and schemes were driving out the old,—a period during which seclusion was to give place to an active participation in international affairs. She ruled China well. Talk of her killing the emperor! Why should she do it? He is her most devoted, loving, and affectionate child. He worships her, and she loves but one thing on earth more than she loves him, and that is her country. She is sixty-four years old. She saw the young and weak emperor beset by factions, dragged hither and thither by the bribed agents of one country and another, and she took again, in her worn, but strong, hands, the reins of power. She will hold them as she held them when in 1862 she sent the bow-string to four of the leading men at Peking who dared to conspire against her. She and Prince Kung ruled China, and, when Kung proved false or feeble, she dismissed him from the foremost place in the empire. She is a great woman. Her people adore her, and foreigners respect her. The troubles of China came after she retired from power. They would never have occurred, had she remained regent. The writers of this paper have confidence in her power and her love of country, and they conclude that capital may be safely invested in China.

And the possibilities of returns are boundless. As China was prompt to adopt the railway for its utility, she will adopt the tramway, the dynamo, the motor, the pavement and water supply and sewerage systems, and eventually all the vast engineering applications which characterize western civilization. Different in his mental and moral philosophy, the Chinaman is like the Caucasian in his physical needs, and will be quick to seize the methods and the machinery of production which have become essential to the life of the western world. China, therefore, offers a market, of inconceivable extent, for the engineering products and the engineering talent which the Anglo-Saxon has in superabundance and seeks to sell.

EQUIPMENT, MANAGEMENT, AND ECONOMIC INFLUENCE OF THE SHIP CANAL.*

By W. Henry Hunter.

DR. ADAM SMITH, who formulated afresh for our forefathers the first principles of political economy, opened his methodical "Inquiry into the Nature and Causes of the Wealth of Nations" by a dissertation on the division of labour, in which he showed that such division was at once a characteristic feature in the progress from a rude state of society to a more complex social condition, and a factor which made for still further progress to still greater improvement.

In the manner of speech of more modern men, that progress has been styled the "march of civilisation," and the rate of advance has been such that the philosophers of the last century, in the most sanguine dreams of their most ardent optimism, could never have even imagined the possibility of such attainment as has already been achieved.

And there can be no halting on the way, much less any standing still; that which humanity has already achieved is a compelling force, making it a necessity for humanity to press still further forward, for "there remaineth yet very much land to be possessed," and the demands of the people become more *exigeant* as well as more articulate as the possibilities of supply are brought more distinctly within their range of vision.

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*The only sound engineering progress is that which harmonizes with, and therefore advances, the great economic evolution which is moving so rapidly in the modern world. Engineering is, in fact, applied economics—the practical working out of material growth. For this reason, the engineer, above all others, is most vitally concerned in questions which are too frequently considered by him to belong to the sphere of the economist or the politician—questions of finance, of tariff, and of national policy.

It is emphatically in the spirit of conceptions as broad as these that the maritime canal must be studied. It is a part of the industrial equipment of the world, ministering to the advantage of all lands, though the service may not be identical to all, either in extent or in the ends to which it ministers. Such effects are too wide to be judged by the ordinary financial tests. The return to investors measures but a fraction of the total gain.

It is with the greatest pleasure that THE ENGINEERING MAGAZINE presents Mr. Hunter's articles, which carry the force of the specialist's authority and the inspiration of the broad view which sees enterprise of this character in its true perspective, as a great factor in the stupendous work of utilizing, to the fullest, the material resources of the earth.—EDITORS.

In the onward march the principle of division enunciated by Adam Smith still obtains, and still will obtain,—must, indeed, become an increasingly dominant force, for the field of its operation is widening, and will widen until it includes the whole earth, and brings under its dominion the entire surface of the planet, whether land or sea.

The reason for this lies at the foundation of things. On the globe, the only sphere of existence of which we have, as yet, experimental knowledge, population is increasing in geometrical ratio,* while the area from which the support of the people is drawn is absolutely stationary and cannot be sensibly increased. The demand for the means of subsistence multiplies, and the resources from which that demand must be met cannot be extended. Economic necessity, therefore, is impelling humanity, even unwittingly, to seek to increase the utility of the food and comfort source, seeing that the possibility of increase in any other direction is denied.

At the present time the effort to obtain larger and more luxurious supplies from the earth is being pursued on well-defined lines of least resistance.

Sir William Crookes, in his recent presidential address to the British Association, indicated other lines, less defined, but not less important, upon which the effort may be pursued in the future,† but, for the present, that with which practical men concern themselves is their recognition of the fact that the instant need is the pressing need, and that scientific provision for instant need is laying a foundation upon which posterity may build in its effort to supply its own needs, although they may be followers, either in sentiment or in manner of expression, of the worthy municipal ruler who, from his place of proud pre-eminence in his own parish, declared that "posterity had never done nowt for him," and deduced from that unassailable premise the conclusion that it was unnecessary for him to take into his consideration any question as to provision for the wants of posterity.

In days hidden in the mist of antiquity the earth was divided among families and tribes, who, as time wore on, developed into antagonistic States and clashing nationalities. In these modern times the earth is being re-divided; for its different parts, under the force of circumstances, are gradually coming to be employed for the purposes for which they are most suitable, whether of an agricultural or a manufacturing sort, or of a sort fitted for the rearing of cattle or of the sinking of mines.

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* Absence of reliable statistics makes assurance impossible, but it seems safe to assume that the population of the globe has doubled during the course of the present century.

† "Through the laboratory starvation may ultimately be turned into plenty,"—*i. e.*, by the extraction and utilisation of atmospheric nitrogen.

It may be admitted at once that glaring exceptions to this rule of progress still exist. Still the half-starved Irish peasant strives to grow oats or barley on the bleak hills of Galway or on the stony wastes of Connemara; but the wretchedness of his condition and the misery of his surroundings bear witness to the futility and the folly of the effort to struggle against the fitness of things.

Still, too, the advance of the tide is impeded and checked by the artificial barriers of national jealousy and of racial antagonism; by hostile tariffs, in which, as well as in frontier fortresses and armed outposts, the traditions of past ages of tribal division find expression to day, and which operate effectively as hindrances to the ready distribution of the products of the earth.

The strivings against nature will cease; men must, of necessity, learn to work on nature's lines, instead of against them, and the artificial and anachronistic barriers will be swept away, not because fiscal experts will cease to wrangle or to prose, not because governments will become more enlightened or men less selfish, but because needs must when hunger, or feared hunger, drives, and because humanity will come to understand that the only hope of support for the race is to make the most of the potentialities provided for that support, and will, as a consequence, treat the earth as a common heritage, with its parts employed for producing that for which they are respectively most fitted.

The working out of this, which, after all, is but a modern commentary on ancient words of wisdom,—for it is long since it was written that "the profit of the earth is for all, the king himself is served by the field,"—has actually begun, and men are experiencing some of the benefits of its operation, even though they are unconscious of the significance of the movement.

But it has only begun, and, as the population increases and the waste tracts, now so rapidly being overrun, are absorbed so that none are left, the movement will be more rapid, more intelligent, and more full of purpose.

The fact that the movement has begun and will extend is the case for the ship canal, for the waterway, wherever it may be practicable, of dimensions sufficient to afford passage to the great ocean-going carriers of produce.

This may seem almost like an anti-climax; but it really is not so, and very little consideration will make this clear.

The proposition is that, in order to draw from the earth the maximum amount of sustenance for the support of humanity, the surface of the earth must be divided in such manner that its different parts will be devoted to the production of the commodities for which they are most suitable.

The corollary to the proposition is that, in order to make those commodities available for all, the different parts must be united by such means of transport and distribution that the fruits of the earth and the products of human labor may be conveyed rapidly and cheaply from any one part of the globe to any other part.

There are still some who, following in the lead of certain of the great men of the century, talk with a fine scorn of the search after cheapness in any direction; but the school is moribund, will soon be defunct, and is, and always has been, without any influence on the trend of events.

The late Prince Consort, whose beneficence of mind and clearness of vision are much more fully understood now than they were by those who were his contemporaries, once said with profound judgment: "Seas do not divide continents; they unite them." The sea is the great highway which nature has provided for the service of humanity, the means by which produce can be distributed and thus rendered universally serviceable.

But it is requisite that the work of nature should be supplemented "by art and man's device" in order to develop to the maximum the utility of the earth.

Seas unite, but they are themselves divided; hence the Suez canal, with its wealth of benefit to the families of mankind; hence, too, will be the Panama canal, the construction of which is one of the most pressing necessities of our own time,—a construction which is actually progressing, and in respect of which more has been achieved than the vast majority of people even imagine,—so much, indeed, that the practicability of the completion of the great inter-oceanic waterway has been demonstrated, actually proved by trial, and that the expenditure of money and of time required for completion can be, has been, forecast, and will be foretold with little less than absolute precision.

Hence, too, in minor degree (minor only in the sense that the distance of sea voyage saved is shorter), the noble Baltic canal,—the Canal de Kiel, as it is styled by its German constructors,—which unites the German ocean and the Baltic sea, and of which the benefits are but beginning to be felt, so conservative is the human mind and so slow to rise to its opportunities, and the Corinth canal, which connects the Ionian sea with the classic waters of the Ægean.

To these are to be added the American projects, greater and smaller, —the first for a waterway which will connect the group of great inland seas between Canada and the United States with the Atlantic seaboard, and the second for a canal across the curious "mailed-fist"-like promontory known as Cape Cod, which will form a fresh connection between the bays of Massachusetts and of Cape Cod and the Atlantic.

These waterways, whether *in esse* or *in posse*, will serve as examples of the first great class of maritime canals,—those which unite divided waters, and thus form part of the highways of the world.

But there is a second class of ship canals, little if any less important than the first, though certainly in each case more local in effect.

The practical effect of a canal of the second class is to enable the sea, the highway of the nations, to penetrate the land to an extent commensurate with the length of the waterway, or, in other words, to push the seaboard inland, and that without waste of useful area or destruction of foreshore.

Of this class are the Amsterdam canal, the Ghent canal, the Pontiloff canal from Kronstadt to St. Petersburgh, the Heyst canal, now in course of construction, which will place the ancient city of Bruges once more in direct communication with the sea, and, last, but not least, the Manchester ship canal.*

The distinction between these two main classes of waterways lies in the broad fact that a canal of the first class is a through road; a canal of the second, a *cul-de-sac*, a road with a dead end.

In the first class, there is no terminus, and no necessity for terminal works. Certainly works are required, and are to be found at either end of the achievement of man's device, where art joins hands with nature, such as quays, piers, breakwaters, etc., but these are but junctions, and the course of a vessel is uninterrupted, is always onward, whether in the ocean, the junction works, or the canal itself.

In the second class, when the vessel has arrived at the end of the canal, she has reached at once the end of her journey and the point from which she should depart for her next voyage—the point from which she *should* depart, but not necessarily the point from which she *will* depart, as this depends upon the facilities which exist for enabling her to obtain a return cargo, as well as for placing that cargo in her holds.

It is obvious that the requirements in respect of equipment differ widely in the two classes.

In the first case, all that is required is that the vessel should be able to steam through the canal with as little loss of time as possible.

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* To these might be added, as somewhat similar in practical value, the estuarial improvements which have been carried out, as on the Seine, by which large vessels have been enabled to reach Rouen instead of being obliged to stop at Havre, as of yore, or as on the Clyde, where the results of the magnificent works executed may be seen by those of the most dim vision in the present position and prosperity of the city of Glasgow, and of the surrounding district.

Provision should therefore be made to allow her to pass, without danger or undue delay, another vessel whose course lies in an opposite direction to her own. It should also be competent for any vessel which had run short of coal, or of fresh water or provisions, to obtain such at either end of the waterway, or, if the need were for special surgical assistance or hospital accommodation for passengers or crew, to find that need provided for.

This is about all that is required in the way of equipment for the through-road canal, and, having provided this, those responsible for its direction and administration can be asked for little more.

Far otherwise is it with the canal of the second class. If that canal is to prove a success, is to fulfil the requirements of its being, its terminal equipment must be of no mean order, and must follow many ramifications and provide for many complicated services.

In the first place, room must be found for the concurrent berthing, in safe, sheltered, and accessible positions, of many large vessels; this necessitates the widening out of the terminus of the canal into commodious dock spaces, bounded by quays and wharves, against which vessels, great or small, may lie in comfort, and to which they may be secured by means of the mooring posts or bollards with which the quays must be fitted at short and regular intervals.

Then the vessel herself is provided for. The next consideration is her cargo, for it is presumed that she has arrived, and is intended to depart, laden ; or, in other words, that there is both an import and an export trade to deal with.

Cargoes are almost infinite in their variety. There is nothing produced, grown, or manufactured upon the earth that does not find its way on shipboard and help to swell the heterogeneous mass. With this mass the terminal equipment must be capable of dealing, with promptness, with dispatch, and with avoidance of injury.

In some of the older ports the practise is even yet to require the vessel to complete her discharge by means of her own tackle ; and under some specially favourable circumstances the operation is carried out with remarkable dispatch. But the port provided by the terminus of the maritime canal cannot be of ancient date, as that canal is of modern development, and in the modern port the shipowner or charterer will expect to find modern equipment.

A regiment of cranes, must, therefore, be provided, and five or six, or even seven, may be required to work at once at the discharge of one large steamer, and, as it is impossible to determine the precise spot at which any particular crane may be required, the cranes must be made movable, and, as they must be operated with great rapidity, it is essential that they should be operated by power.

Until comparatively recent times power was applied to such cranes by steam, either directly through a small engine forming part of the structure of the crane, or indirectly through water under pressure, the pressure usually adopted being from 700 to 1,000 pounds to the square inch. But within the last decade a formidable competitor with both the steam and the hydraulic crane has made its appearance in the field,—*i. e.*, the electric crane. It is not possible to discuss, within the limits of this article, the merits and demerits of these types. Each has its advantages and its disadvantages, and the final decision will lie with the type of crane by which the work demanded can be done most readily and most cheaply. It looks at present as if in the struggle for existence the electric crane would survive as the fittest of the three. At any rate, the results of the only exhaustive tests of the three types—those made in 1892–93 in Rotterdam by Mr. de Jong, the engineer-in-chief to the port, where the three are actually at work side by side—certainly indicated that this conclusion will be reached.

The cranes, or the ship's tackle, or perhaps the cranes and the ship's tackle combined, having landed the cargo on the quay, it is requisite that provision should be made for its immediate removal. Quay space is limited and valuable, seasons are short and condensed, and it is one of the problems ever present with the management how to deal with a maximum tonnage on a minimum space and in a minimum time.

The cargo, once landed, must then be got away at once. With a well-devised system of roads and railways, combined with a little foresight on the part of the consignees, a portion of the cargo may be loaded direct into lurries or railway trucks, and forwarded at once to its destination; but this can be, at the best, but a small percentage of the whole, and the rest remains to be disposed of.

For heavy, rough materials, such as timber, pig iron, slates, ores, etc., out door storage grounds are sufficient. These storage grounds, however, must not only be levelled and drained, but should be accessible, and should be traversed by railway lines and intersected by cart roads. As it is a *sine qua non* that the materials should be placed upon the ground at once, and eventually removed therefrom as expeditiously and economically as possible, with a minimum amount of handling and carrying, it is essential that the area of the storage ground should be sufficient to admit of much detail of classification of the material stored, whether of marks, or of sizes, or of quality.

There are other materials as bulky as any of the above named, such as cotton, wool, grain, etc., for which protection from wind and weather is indispensable. The same remark naturally applies als to all manufactured goods, whether imported or for export, to all food stuffs, and to such commodities as fruits and vegetables.

The necessity for protection "calls for" shed accommodation on an extensive scale. Cargoes have become enormous in bulk and in variety,* and must be differentiated and classified as they are discharged into the sheds. Quay space is difficult and costly to obtain, particularly quay space which is within the limits of the radius of the cranes. These circumstances have led to the evolution of the type of shed in which the quay space available is multiplied by the addition of upper floors, or stories, to the original single-story shed. The single story was first doubled, then the two-story shed became a shed with three floors, and now all the docks of the Manchester ship canal sheds have been or are being built with four floors, all being within the reach of the hydraulic cranes which work on the dock side and which swing the goods on to the tilting platforms with which the floors of the sheds are respectively furnished.

But the demand for accommodation advanced by trade cannot be held to be fully met by the supply of a large and convenient shed space. Goods are imported for which no present market may be found, or of which the market price may be expected to rise; and it is required that they be housed for weeks, perhaps months. For this purpose the transit sheds are unavailable by reason of the necessity of turning over the largest possible tonnage at each berth in the docks. Warehouses, therefore, must be provided. It is not essential that these warehouses should occupy quay space or encumber berths which may be more profitably reserved for more nimble traffic. It is necessary only that adequate railway connections between the discharging berth and the transit shed, on the one hand, and the warehouse, on the other, should be provided, so that the goods may be conveyed to their place of lodgment at the least possible cost, and in the shortest possible time.

Even the provision of ample warehousing room does not exhaust the demand, which is, in truth, inexhaustible. Special lines of traffic must be specially provided for, if the canal terminus is to fulfil its purpose and to keep abreast of the times. Take, for instance, the grain trade, already pre-eminent in its importance, and likely to increase rather than diminish as the re-division of the earth's surface proceeds. Take, too, the oil trade, annually growing greater in bulk, and more necessary for human comfort and advancement, for it is truly an enlightening trade, dispelling the gloom of dark hours and helping the people to lengthen their days by stealing more than a few hours from the night in the winter seasons.

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* "The following are the particulars of a cargo recently discharged at Liverpool: 605 head of cattle, 2,634 quarters of dressed meat, 50 rounds of dressed meat, 342 logs of walnut, 6,588 bundles of lumber, 444 hogsheads of tobacco, 1,500 pails of lard, 425 tierces of lard, 1,338 boxes of bacon, 18,450 sacks of flour, 5,000 qrs. of wheat, 3,000 qrs. of corn, 2,193 parcels of hardwood, 839 boxes of hams, 479 bales of cotton, and a large amount of other merchandise."—*Shipping &c. Gazette*, September 8, 1898.

Whether regarded from the point of view of the port of origin, or that of the port of distribution, both these lines of traffic demand special provision. The quantities to be dealt with have become so enormous that the old-fashioned methods of handling grain in small parcels and of moving oil about in barrels are hopeless to-day. Now the grain must not only be loaded or discharged in vast quantities, but be weighed and stored in such manner that these great quantities can be so divided and sub-divided that, without appreciable addition to the cost, shiploads of thousands of tons can be rapidly and certainly distributed in lots of 60 tons, or even in smaller quantities. To meet this necessity the American grain elevator has been evolved. Of that elevator space forbids any detailed description here. It must suffice to say that it has successfully invaded even the British islands, in which, as Edmund Burke said, "men's minds move slowly"; that its conquest of the grain trade will be sure and complete; and that the provision of some sort of elevator as an essential part of the equipment of any ship canal must now be recognized.

For the oil trade the provision is of a more simple character. The tank steamers in which the oil is now carried, in bulk, are fitted with all necessary pumping power for the loading or discharging of their cargoes, and require only a safe berth with pipe connections to the great circular tanks, something after the appearance of gas-holders, n which the oil is stored for distribution.

Without stopping to dwell upon the minor, but still absolutely essential, parts of terminal equipment, such as electric lighting, fresh-water-supply for vessels, fire protection appliances, etc., we pass to the all-important question of the means of distribution or collection of goods, whether imported or to be exported.

Apart from such means, all the rest will be bootless. Where a system of inland canals exists, such system should be not only utilized, but developed, difficult as such development may be in most countries to-day, owing to the short-sighted policy of the past. But the inland canals can take only a small part of the traffic with which the maritime canal can deal. Hence the necessity that to every dock or arm of a dock, to every transit shed and every goods warehouse, as well as to every storage ground, a good and convenient cart-road should be formed, so that the road may supplement the canal for collection and distribution.

But road and canal together will be found totally insufficient for the transport of the mass of merchandise to be dealt with. Therefore, wherever the road may be carried, the railway must follow. Not only a railway to each dock, or shed, or warehouse, but a railway on each side of each. Nothing else will suffice. This network of railways will involve the formation of through roads, over which all the goods may be conveyed, and of sidings of no ordinary dimensions,—marshalling sidings, stock sidings, etc., by means of which the goods may be sorted and the trucks apportioned.

The result of all this will be that, under the pressure of circumstantial necessity, the docks forming the terminus of any large waterway will develop not only into a vast emporium of merchandise, but into a huge railway goods station, and the equipment of such a station becomes part of the equipment of a great ship canal.

The capital cost of these works is, of course, very heavy, but judicious capital outlay will have a marked effect in the reduction of working expenses and of maintenance, and such outlay will be found to be money well spent,—money for the expenditure of which the human family will be the better, so far as the necessities and the comforts of life are concerned.

And no end can be discerned to the benefit, for it increases year by year.

(*To be continued.*)

OLD AND NEW FORMS OF THE SUSPENSION BRIDGE.

By Gustav Lindenthal.

IT is interesting to note that the oldest form of bridge—the suspension bridge—is the slowest in development into rational forms in iron and steel. While every other type of bridge—the beam or truss, the girder, the arch, and the cantilever—has been thoroughly exploited, correct theories and construction details for all of them having been established, the suspension type has only recently received close mathematical consideration, with a view to making it serviceable for the concentrated loads of modern railroad conditions.

Suspension bridges, as every one knows, are as old as mankind, and are found in all parts of the world, among savages as well as among the oldest civilizations. It was natural to bridge a stream or abyss with ropes of twisted vines, sticks laid across them forming the footpath. That some very bold constructions of this primitive kind were carried out is shown by a description (*Engineering*, 1892, I, page 2) of such a bridge in the Caucasus; it had a span of eighty feet, carrying a mule path, and the ropes consisted each of three twisted creeper stems. It required only the knowledge of a stronger tension material, like wrought iron, to suggest that construction for longer spans among more advanced nations. And, indeed, all the first historic iron suspension bridges, as early as the sixteenth century in China, were built on this primitive model, the path or road resting directly on the iron chains. So also were the first wrought-iron chain bridges in England, about the middle of the eighteenth century.

A horizontal roadway, supported by vertical rods from the chains above, was an improvement introduced for the first time in 1796, in North America, by James Finlay, a New England native. He built spans of three hundred feet, in which the chains consisted of long links, or rings, forged of round or square bar iron. Bridge chains consisting of the more serviceable flat link or eyebar were first manufactured in London by Samuel Brown (in 1811), and the facility of erection which they afforded induced the eminent engineer, Telford, to use that system for the famous and still well preserved bridge over the Menai strait, with a span of six hundred feet (1818–26).

The production of puddled iron in large masses, and its gradual cheapening in the beginning of this century, changed the character of iron bridge building completely. Until then cast iron had been used in the form of arches; but it was found that wrought-iron suspended structures were more easily and cheaply built. After several badly-

HAMMERSMITH BRIDGE OVER THE THAMES, LONDON.
Built by W. T. Clarke, 1827.

designed cast-iron bridges had collapsed in England with disastrous results, wrought-iron suspension bridges were preferred, and during the first half of the century were the fashion everywhere.

In rapid succession were built many of the architecturally-famous structures: the Hammersmith bridge in London (400 feet span, 1827) by W. T. Clarke; by the same engineer, the beautiful bridge over the Danube at Buda Pest (600 feet span, 1839–45); the Seraing chain bridge in Belgium (350 feet span, 1843), the first suspension bridge with iron towers; and the fine chain bridge in Prague (two spans of 420 feet each, 1838–42), by Schnirch, the engineer who built later the only railroad suspension bridge in Europe, over the Danube canal in Vienna (taken down and rebuilt in 1885), and in the same city the fine Aspern bridge (200 feet span, 1865). The longest span with flat eyebars in Europe is the Clifton bridge at Bristol, England (700 feet span, 1840–64), built by Brunel & Hawkshaw; while the Point bridge at Pittsburg, Pa., by Hemberle, is the longest of that kind in America (800 feet span, 1876).

It is not generally known that the first use of steel in bridge building was in a suspension bridge over the Danube canal in Vienna (300 feet span, 1828). The flat eyebars of the chains were made of puddled steel. The bridge was taken down thirty-two years later, about the time when the St. Louis arch bridge was erected,—the first bridge in which cast steel was used.

To the United States, again, belongs the credit of the first wire suspension bridge (400 feet span, 1815) over the Schuylkill river at Philadelphia. All the wire bridges of Europe were built later: namely, several smaller bridges in France, by the Seguin Brothers (1821); a small wire bridge in Geneva, Switzerland, by Colonel Dufour (1823); and the famous wire suspension bridge at Freiburg, Switzerland, by M. Chaley (1832), the longest bridge span (860 feet) on the continent to this day. Other well-known large wire suspension bridges are at Roche Bernard, France, by Le Blanc (650 feet span, 1840), and at Lorient, also in France (600 feet span).

The Suresnes bridge, at Paris, with a middle span of 260 feet and two side spans of 180 feet each, is noteworthy for its cables, composed of thin iron ribbons, which proved to be very serviceable for the purpose, but are of less strength than wire.

In the United States were built not only the first but the longest spans of wire suspension bridges. Here the greatest advance was made in their construction. The principal builders were Charles Ellet and John A. Roebling. Each engineer followed a system of his own. Charles Ellet arranged his wires in the form of strands laid side by side, with iron bars lashed across them, from which the suspenders were hung, supporting the roadway. John A. Roebling built up his wire cables into compact cylindrical form, and wrapped them with a continuous wire from end to end, thus covering the supporting

SUSPENSION BRIDGE OVER THE DANUBE AT BUDA PEST.
Built by W. T. Clarke, 1845.

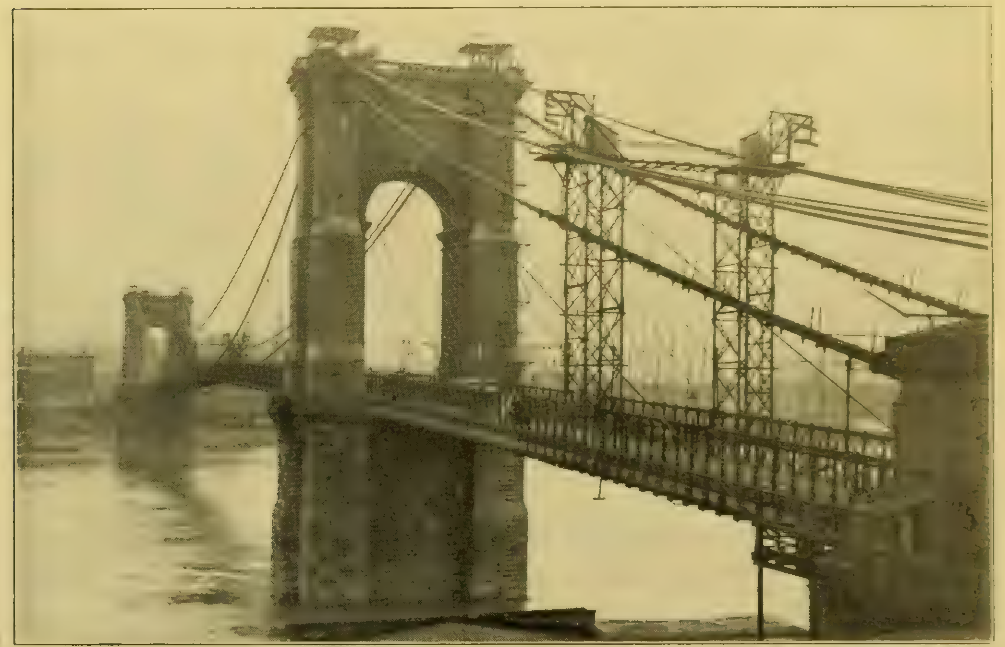
wires completely. The suspenders were fastened to clamps encircling the cable. He also always cradled his cables,—*i. e.*, drew them into inclined planes for greater lateral stability,—and employed near the towers auxiliary smaller cables or ropes, called stays (not a good feature), to hold up the roadway.

The controversy and discussion between the two engineers was very animated at times, each claiming special advantages for his system. But there is no question that the Roebling system was by far the better one. One convincing test of its merits was afforded by the Wheeling suspension bridge (1,000 feet span over the Ohio river), built by Charles Ellet in 1846. Shortly after it was opened to traffic, a severe gust of wind twisted the roadway upside down, and nearly blew the bridge into the river. Roebling repaired it, and consolidated the different strands into solid inclined cables, thus making the bridge more rigid and more secure against wind-pressure.

Charles Ellet was also the builder of the first wire suspension bridge (taken down in 1854) across the Niagara chasm below the Falls. It was for this bridge that the first line across the gorge was drawn over by means of a kite, to which a heavier line, and finally the first wire, were tied that they might be pulled across. The wires were then formed into strands of his peculiar construction. To show the safety of his structure, Ellet undertook the daring feat of riding on horseback across the swaying bridge (7½ feet wide, intended only for pedestrians) before it was provided with side guards, and when no one would yet trust himself to cross it on foot.

But no one else in his day so improved the construction of wire suspension bridges as did John A. Roebling. The famous and often-described Niagara suspension railroad bridge (recently rebuilt with steel arches) was by no means his boldest attempt in that line. He planned a railroad suspension bridge of 1,230 feet span over the Kentucky river (in 1857), the construction of which was begun, but was stopped by the financial failure of the bridge company. Roebling was also the first to use the suspension bridge for supporting aqueducts, for which it is especially well adapted, because of the permanent uniform load, which requires no stiffening system. The largest bridge of this kind, and a famous one in its day, was the Allegheny suspension aqueduct at Pittsburg, Pa., of seven spans of 162 feet each. It ceased to exist in 1856. The Cincinnati and Covington bridge over the Ohio river (1,050 feet span, 1867), which has just been widened and reinforced, was the largest wire structure, until the completion of the New York and Brooklyn bridge (1869–83).

In a history of suspension bridges, Roebling's old Smithfield street bridge at Pittsburg, Pa., (1847), with eight spans of 188 feet each, deserves mention from the fact that it sustained continuously, for more than thirty years, the heaviest street traffic ever put upon a suspension bridge. Eight horse teams, drawing heavy castings and loads of pig iron and coal, crossed daily, subjecting the cables to a strain of more than half their capacity. The loaded span sometimes deflected two feet, the unloaded spans rising about as much. On taking down the bridge in 1882 (when it was rebuilt from my designs with a new and heavy structure of longer spans and lenticular steel trusses), the cables were cut up. The wires would curl up to the curve they had in the coil thirty-five years before. This was a most remarkable fact, showing that, in spite of the very severe strain, the wires had suffered no impairment of their original strength. They were found in very good condition, and nearly free from corrosion, although the painting of the cables had been neglected for many years. The thick paint between the cables had been an excellent preservative. The severe test to which these wire cables had been exposed proved the exceptionally durable and safe qualities of wire for bridge construction, if kept tolerably free from corrosion.



CINCINNATI AND COVINGTON BRIDGE OVER THE OHIO.
Built by John A. Roebling, 1867; view taken during present reconstruction.

But it is also true that, wherever the wires or bars are not protected against corrosion, the structures weaken and finally collapse. Several disasters have been traced to that cause. The first prominent wire bridge to break down was the one at Angers, in 1850, under a troop of soldiers marching over it. Investigation showed that the wires were corroded near the anchorages.

Another calamitous instance was the collapse of the suspension bridge at Ostrawitza, in Austria, in 1886. The eyebars had been nearly destroyed by rust where they passed into the masonry.

There have been several instances of collapse of smaller suspension bridges in America, but none was accompanied by serious loss of life. A peculiar serio-comic mishap was the collapse of a wire rope bridge at Franklin, Pa., in which the ropes were secured at the anchorage in iron sockets filled with lead. A fire broke out in an adjacent house, the heat from which softened the lead in the rope sockets; the ropes pulled out, and the bridge dropped into the river.

The belief that a suspension bridge cannot have the rigidity possessed by other forms of metallic bridges is still prevalent. It is, however, a mistaken belief, derived from the old, swaying, oscillating suspension bridges, which were put up as cheaply as possible, and at a time when the methods of making them rigid were not yet understood, and when no theory had been established according to which a proper stiffening system might be proportioned.

How persistent that prejudice is, even among engineers, appears from a statement, in a recently-published treatise on bridge designing by a prominent bridge engineer, that, compared with a suspension bridge, the cantilever type (known to bridge experts as the least rigid truss type) is rigidity itself. Most other engineering text-books contain similar opinions, dating from a time when very little or no provision was made for rigidity, because it was not absolutely necessary. A swaying bridge was better than no bridge at all, and, for economical reasons, heavy stiffening girders for street traffic were regarded as an unnecessary addition to the dead load, greatly increasing expense without adding to safety. The opinion of George Stephenson, from his experiments for the Britannia bridge (which was at first intended to be a suspension bridge), that, in order to make a suspension bridge as rigid as a truss bridge for railroad trains, the stiffening trusses would have to be nearly strong enough to bear the entire load, has not been endorsed by the later advanced theoretical knowledge.

Analysis of the characteristics of a suspension bridge shows that its strength depends upon three principal elements,—the cables, the towers, and the anchorages. Provided these three be strong enough, the suspension bridge is safe, though it may sway or oscillate. No other bridge can sway from any cause without imminent danger.

Theoretically, the suspended arch of a cable is in all respects equal in resisting force to the erect curve of an arch bridge. If the erect arch can be made rigid, so can the suspended arch be, and by the same methods. In the suspension bridge the arch is in tension, which must be resisted by anchorages; in the arch bridge the erect curve is in compression, which must be resisted by abutments. But the suspended arch has the exclusive advantage of being in stable equilibrium ; it requires no lateral bracing to maintain it in position, whereas the erect arch is in unstable equilibrium, and, if not held up by vertical and lateral bracing, must collapse. Hence the greater stability and safety of the suspension bridge. It is, in fact, of all known systems the most stable and safe. In any other form of bridge, if a single supporting member be displaced or ruptured, collapse of the entire structure is the almost inevitable result. The suspension bridge, on the other hand, need not be rigid, in order to be safe. It can be designed at will of any degree of stiffness, from the mobility of a wash-line to the rigidity of a stone arch, save for slow changes os form caused by changing temperature. In a suspension bridge the quality of rigidity is a convenience; in all other bridge systems it is a necessity. A recent occurrence on the Brooklyn bridge demonstrated this distinctive feature. The crowding of several heavily loaded street cars on the main span overstrained the stiffening trusses in a manner perfectly intelligible and foreseen by bridge engineers. The chords gave way by buckling. The public became unnecessarily alarmed as to the safety of the bridge, which was not affected by the failure of the stiffening trusses. The bridge is designed for street traffic only, which is always more or less distributed over the entire length of the roadway, and crowding can be avoided by police regulations. If the structure had been intended for railroad traffic, or for concentrated loads, it would have had to be designed differently. Modern American railroad structures must, for instance, be able to sustain with perfect safety the load of locomotives, weighing 100 tons on a wheel base of 15 feet. If such a locomotive attempted to cross the Brooklyn bridge, it would wreck the metal floor and trusses from end to end, but the safety of the cables, towers, and anchorages would remain unimpaired. Similarly, in the old Niagara bridge, the stiffening trusses were repeatedly overstrained,

NEW YORK AND BROOKLYN SUSPENSION BRIDGE.
Commenced in 1869 by John A. Roebling; finished 1883 by Washington A. Roebling.

and the steel chords several times broken from the excessive load of modern locomotives and trains. Nevertheless, the traffic could be kept up with safety; the trains could not drop into the abyss because again the cables, towers, and anchorages were strong enough, and safe. If a similar buckling or breakage of bridge frame should happen on a cantilever, arch bridge, or truss bridge, then bridge, train, and all would go down without fail. And thus it is that, because a suspension bridge can safely exist without the amount of bracing which every other kind of bridge requires, it can be built lighter, as far as the superstructure is concerned. Thus, the Brooklyn bridge, which has a middle span of 1,600 feet, and flanking spans of 920 feet each, has an average dead load per lineal foot of 7,500 pounds, of which the weight of iron and steel is 6,200 pounds. It carries four rapid-transit tracks, two roadways, and a promenade, and is proportioned for a moving load of 2,000 pounds per lineal foot. With the same weight of metal (6,200 pounds per lineal foot) it is impossible to build any other kind of bridge, of the same width (85 feet), the same length of spans, and the same carrying capacity.

Compare it with the largest bridge in existence, the great Forth bridge in Scotland, which is a cantilever structure for a double-track railroad, and proportioned for a moving load of 4,000 pounds per lineal foot, which is twice the capacity of the Brooklyn bridge. The main spans are each 1,700 feet long (6 per cent. longer than that of the Brooklyn bridge). The Forth bridge contains an average of 17,000 pounds of steel per lineal foot of bridge, exclusive of the steel in the towers. That is to say, it requires 4.25 pounds of steel per lineal foot of superstructure to carry one pound of moving load, against $3\frac{1}{10}$ pounds of steel in the Brooklyn bridge required for the same service. The latter is less rigid, but, for its purpose, just as safe.

If the same weight of steel (17,000 pounds per lineal foot of superstructure) were put into a wire suspension bridge of 1,700 feet span, designed in accordance with present advanced knowledge, it could sustain a moving load of 8,000 pounds per lineal foot of bridge, which is double that of the Forth bridge and four times that of the Brooklyn bridge; moreover, it would be just as rigid as the exceptionally-strongly-braced Forth bridge, over which the fastest railroad trains pass daily, at the rate of one mile per minute.

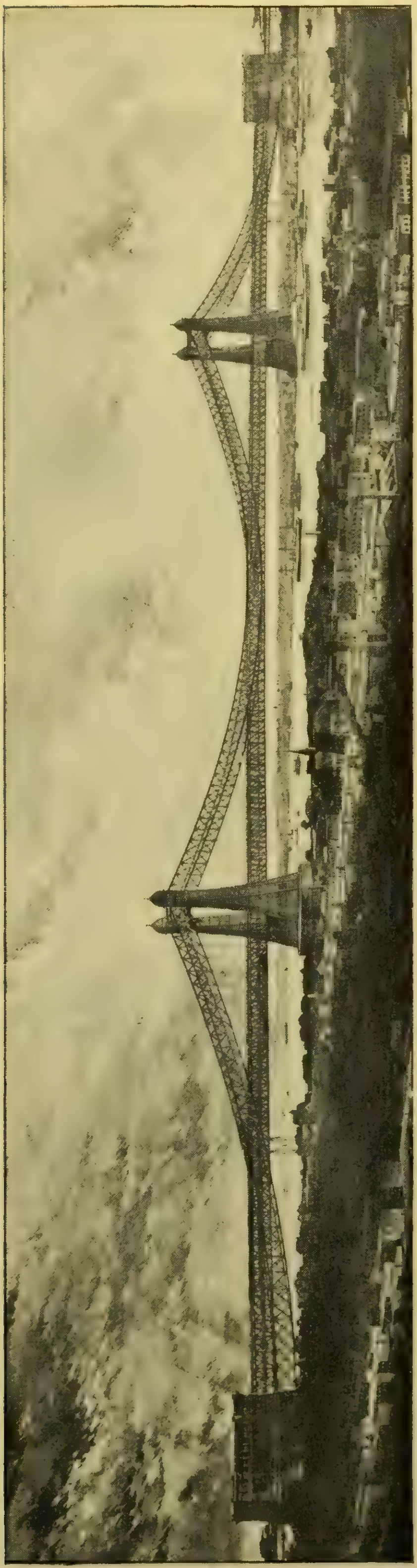
The comparison of weights of superstructure alone would, however, be misleading in showing an economy for the improved and rigid suspension system. The cost of towers and anchorages must also be taken into account; so that the suspension type may not always be economical, particularly for shorter spans. This, however, does not affect the question of rigidity, mainly considered here.

CLIFTON BRIDGE AT BRISTOL, ENGLAND.
Commenced by Brunel, 1840; finished by Hawkshaw, 1864.

No rigid railroad suspension bridges have been built as yet. The two old suspended structures over which railroad trains passed—namely, the Niagara wire bridge, mentioned before, and the chain bridge in Vienna, built in 1860 by Schnirch—were semi rigid, faulty in design, and too weak for the increasing loads of modern locomotives and cars. At their time no reliable theory of stiffening such structures existed. The Niagara bridge (820 feet span, single track), after being reconstructed in 1880 with steel stiffening trusses, contained only 2,000 pounds of metal per lineal foot, while the double-track arch structure (550 feet span) which replaced it last year contains 10,000 pounds of steel per lineal foot.

Any other bridge of the same span and same lightness of construction not only would have been unable to carry railroad trains across the chasm, but would have collapsed under its own weight. Nevertheless, the fact that this bridge deflected under railroad trains (about twelve inches) had been interpreted and harped upon as proving the unsuitability of the suspension type for railroads, while actually the contrary was proven. No other bridge with so little metal in it has ever done the work of that span.

Under ordinary conditions the rigid suspension bridge, suitable for heavy railroad traffic, will show no economy over other bridge types for spans where the moving load exceeds the weight of superstructure. For semi-rigid and rigidless suspension structures no such limitation of economical spans holds good.



THE PROJECTED NORTH RIVER BRIDGE OVER THE HUDSON, AT NEW YORK. DESIGNED BY GUSTAV LINDENTHAL.

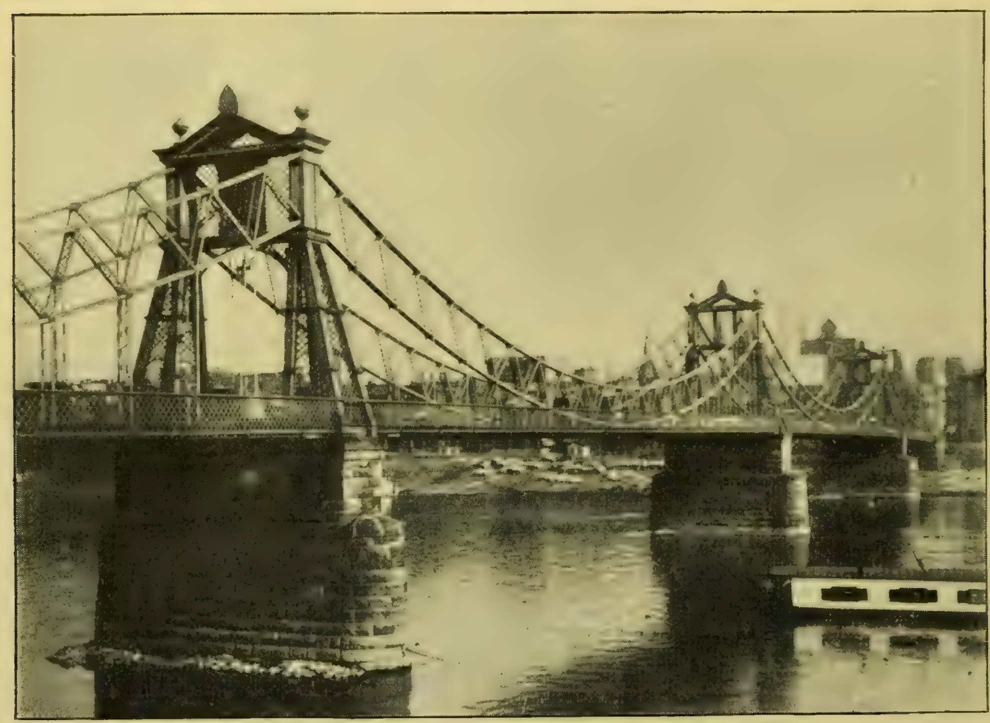
But, for the longest possible spans for any kind of traffic, the steel wire suspension bridge is the only available type. For this reason the projected railroad bridge over the North river at New York, requiring a span of 3,100 feet, will be a steel wire suspension structure; it will be as rigid as the Forth bridge. Careful calculations and estimates, made for diferent designs, showed in this case that the multiple-track (from six to fourteen tracks) single span of 3,100 feet will cost less than would a bridge requiring a pier in the river, for which rock bottom could be found only at a depth of 260 feet. Here the cost of the main or river span alone could not be considered without the cost of the shore spans, the length and character of which are greatly affected by local conditions, so that a combination of circumstances, producing the before-mentioned economic result, will hardly be found on any other large river or estuary.

The North River bridge will differ from, and be a great advance upon, suspension bridges as built heretofore, in almost all details of construction. To mention one feature, each of the four cables will be in the form of quadruple chains, one above the other, each chain composed of wire links connected by huge steel pins. The special advantage of this form of cable construction will be that the chain links can be made of exact length at the shop with machinery, so that all wires will be strained alike. In this way the cables can be finished under roof, like any other steel parts of the bridge. This is not possible with wire cables of the kind used for the Brooklyn bridge, or with cables composed of wire ropes. For then the wires or ropes must be put in place one at a time, adjusted to proper length, and then compacted into a solid cable. The adjustment requires calm weather, as wind causes the wires or ropes to vibrate, and is a time-consuming operation, made more difficult in that the wires

BRIDGE OVER THE TIBER AT ROME. BUILT IN 1889.

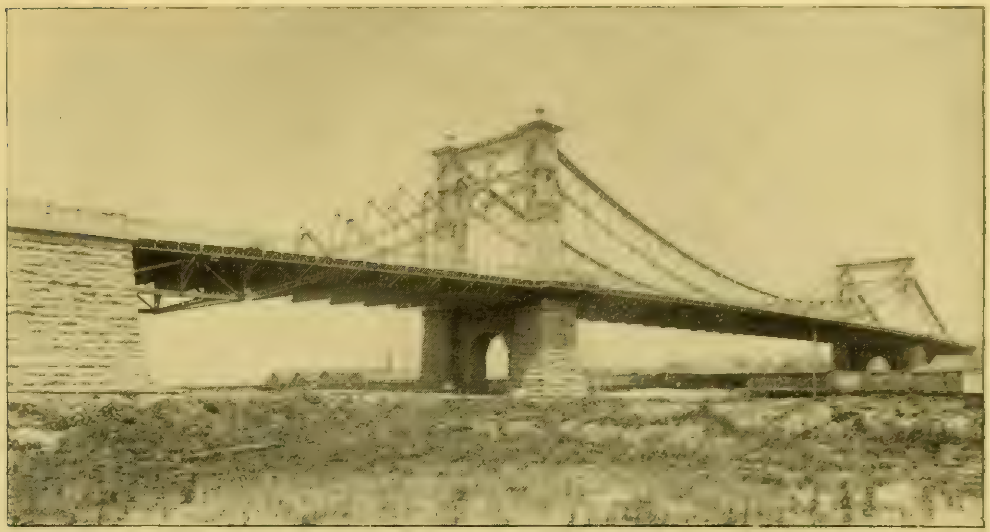
are unequally heated by the sun. While there are no rigid railroad suspension bridges in existence, several have been built for street traffic. Among them is the Point bridge in Pittsburg (800 feet span, 1876). The stiffening system in this bridge is above the curve of the chains, in the form of segmental chords meeting at the center of the span. The bracing is between the chords and the cable.

A bridge of apparently similar construction, but still radically different in principle, is a highway bridge in Rome, built in 1889, over the Tiber. The bracing in this bridge is inserted between two chains on each side of the bridge. The chains intersect on the lines of lop-sided hyperbolas at the center of the bridge. The equilibrium curve passes midway between the intersecting chains, both of which are designed to remain in tension from moving loads. The difference between this bridge and the Pittsburg Point bridge is that the equilibrium curve in the latter corresponds entirely with the chain.



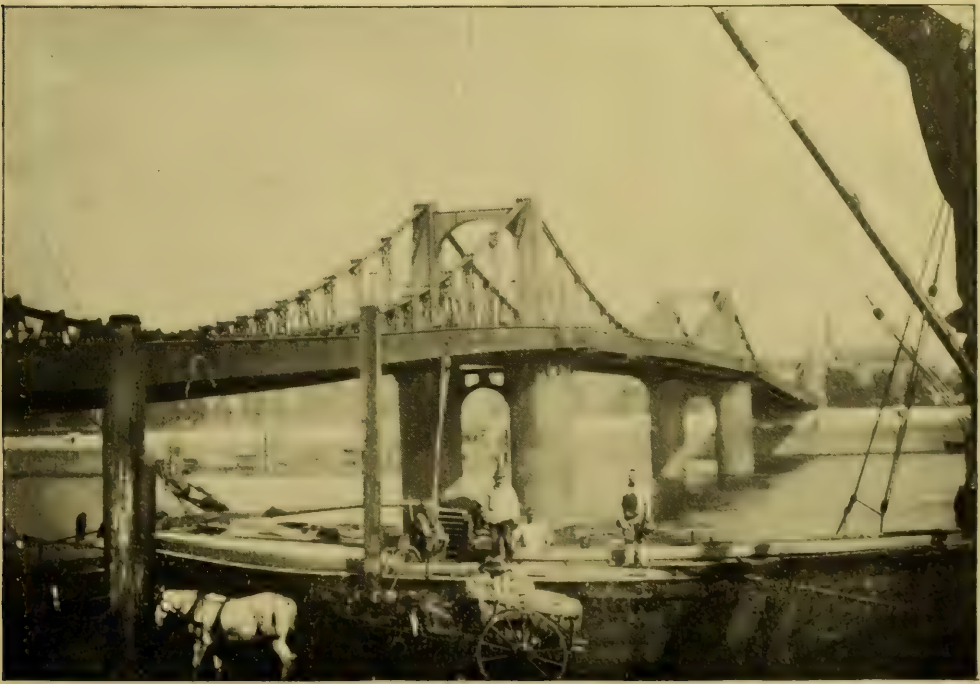
SEVENTH STREET BRIDGE OVER THE ALLEGHENY RIVER, PITTSBURG, PA.
Built by Gustav Lindenthal, 1885.

Another stiffened suspension bridge in Pittsburg is the Seventh Street bridge over the Allegheny, for highway purposes. It has two middle spans of 330 feet each. In this bridge the uniform load is carried on each side equally, by both chains. The bracing between them serves as a stiffening system, which proved entirely adequate for the heavy street traffic.

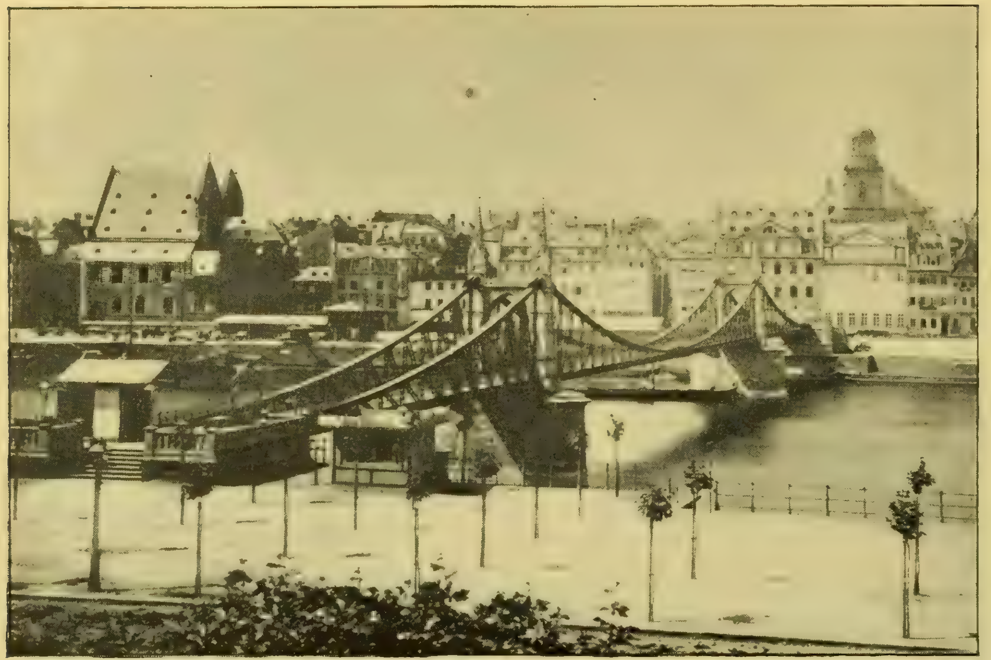


JEFFERSON AVENUE BRIDGE, ST. LOUIS, MO.
Built by C. Gayler, 1890.

The suspension bridge at Jefferson avenue in St. Louis, built in 1890, carries a wide avenue on a 400-feet span over the railroad tracks. In this bridge the upper arch is the supporting member, formed of eyebars, and the lower arch is attached merely for stiffening purposes. The bridge is as rigid in every way as a truss bridge. The Lambeth bridge in London sustains a heavy street traffic with comparative rigidity, although the construction is not free from serious

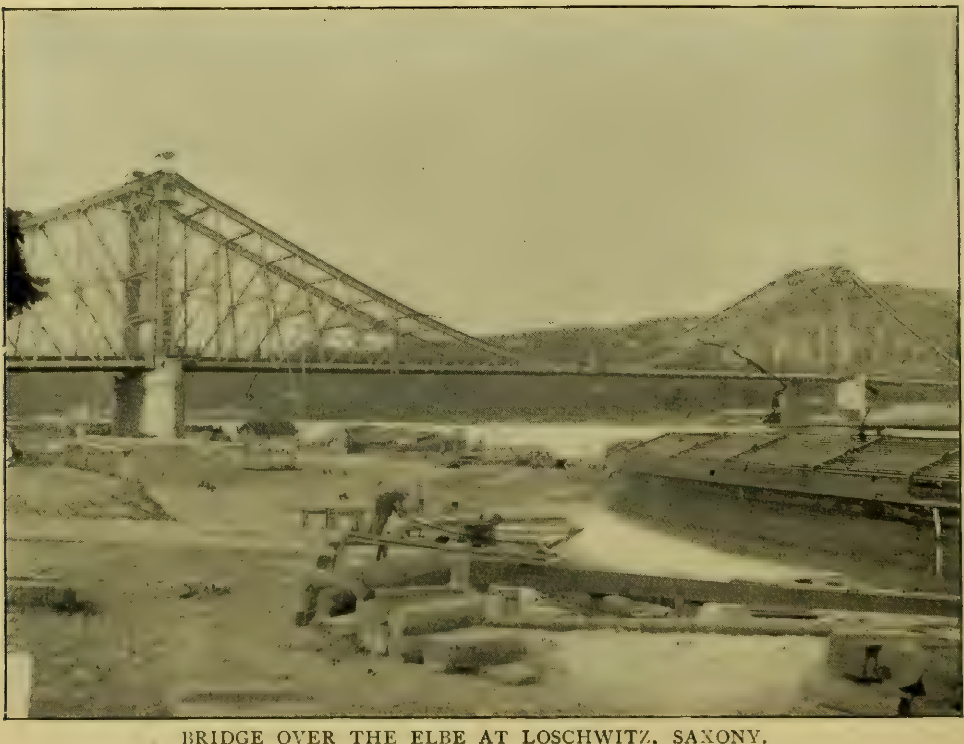


LAMBETH BRIDGE OVER THE THAMES, LONDON.
Built by Barlow, 1862.



SUSPENSION BRIDGE OVER THE MAIN, FRANKFORT, GERMANY.
Built by Schnirch, 1869.

faults. Another example of a rigid suspension bridge is the one at Frankfort-on-the-Main,—a riveted structure carrying a footway across the river. The bridge at Loschwitz, over the Elbe, is also classed as a rigid



BRIDGE OVER THE ELBE AT LOSCHWITZ, SAXONY.
Built by Koepke, 1893.

suspension structure with riveted members, although it is combined with a cantilever feature of doubtful utility.

The new East River bridge will, in appearance, resemble the existing Brooklyn suspension bridge,—with the exception of the towers, which will be of steel,—but it will differ greatly from it in the important feature of the stiffening truss, which will have double the height of the trusses in the existing bridge, and will be of more rigid construction throughout. It is intended to carry, besides the wagon and street traffic and electrical cars, locomotive trains on two lines.

The suspension bridge system is particularly applicable to locations where rocky shores on both sides afford natural anchorages, and where the navigation interests preclude an arch bridge. The great expense of heavy masonry anchorages can then be saved.

THE NEW EAST RIVER BRIDGE BETWEEN NEW YORK AND BROOKLYN.
Designed by L. L. Buck ; now in process of construction.

The facility of erection without falseworks, and the graceful architectural appearance of a suspension bridge, should give it the preference in many places where at present only truss bridges, or cantilever bridges, are thought of. For these reasons the authorities of Buda Pest have recently decided in favor of the suspension system for the new bridge which is being built over the Danube. It will be a single span of 1,000 feet over the entire river, with double chains of eyebars. It will be the longest suspension bridge in Europe, and a very handsome one,—a fitting mate to the existing suspension structure, which is world-known for its architectural beauty.

A great deal could be said of those details for suspension bridges which affect their durability, and their facility of fabrication, erection, and maintenance ; for instance, whether the anchorages should be made accessible, or solidly walled in ; whether the cables should be constructed of such forms that they may be readily erected, inspected, reinforced, or replaced. Some erroneous theories still prevail as regards the different systems of stiffening and the effect of temperature changes. Improvements over the old standards will certainly be made. But to deal with these questions, even in a cursory manner, would exceed the limits of this article.

THE STEEL FOUNDATION OF THE SHIP-BUILDING INDUSTRY.

By James Riley.

AT the time when the Landore Company was occupied with the execution of the first contract for the supply of the new "mild steel" to the British admiralty, there were in existence—in Great Britain at least—only three works established for the production of steel by the open-hearth process. These were the Landore Siemens Steel Company, near Swansea, South Wales; the Steel Company of Scotland (of which the writer became manager in 1878) with works at that time at Newton near Glasgow, to which they subsequently added the Blochairn Works, also near Glasgow; and the Panteg Steel Works, near Newport, Monmouthshire.

There were open-hearth furnaces at two or three other works, but these three alone were designed explicitly for the manufacture of Siemens-Martin or Siemens steel. Both the Landore and Newton works had been constructed after the plans of the late Sir Wm. Siemens, and at both it was contemplated that the principal product would be rails. The great fall in the price of rails after 1874, and the rapid and great developments and improvements of the bessemer process,—also principally directed to the production of rails,—had caused the utmost concern to those closely connected with the management of these two works, as it began to be realized that rails could not be produced as cheaply by the open-hearth as by the bessemer process. It became, therefore, a matter of vital interest that other outlets should be found for the products of the Siemens process.

In these circumstances the adoption of "mild steel" by the admiralty was of great importance, and the thorough satisfaction expressed not only with the manner in which the contract was executed, but also with the behaviour of the steel in the process of ship-building and afterwards, was of absorbing interest to the producers of open-hearth steel. Possessed of the tolerably firm vantage-ground of this undoubted success, it was determined to explore the various industries consuming iron and steel, to find outlets for the new product.

Neglecting many subsidiary—although in the aggregate important—uses to which the new material could be applied, it was apparent that it would be wanted chiefly for ship-building, boiler construction, bridge-building, and—in South Wales—the manufacture of tinplates,—iron plates coated with tin,—one of the staple industries of that part of the country. At an early stage of the period under review the writer (then manager to the Landore Company) turned his attention to the production of steel tinplate bars, and was successful in supplying these of a quality and at a price which were more satisfactory than those of the charcoal iron bars then in universal use. As there were many works which did not manufacture their own iron bars, it was to these that application was first made, and of course it was less difficult to achieve success here than in the case of those who, producing bars for their own consumption, were naturally averse to seeing their charcoal furnaces fall into desuetude. In the end, however, there was no help for it ; the latter had to follow the course adopted by the former, who had found the working of "mild steel" advantageous in many respects. Thus was initiated a revolution in the tinplate manufacture which in a very few years was complete, Siemens mild steel having totally displaced charcoal iron, and bessemer steel the commoner quality known as coke bars. The limitation here set forth, by which Siemens steel could take the place of only the charcoal iron bars,—not the common coke bars,—was that of price. The only inducement the steel-maker had it in his power to offer—quality being considered sufficiently good in either case—was that of price, which was of course ultimately governed by the cost of manufacture. From this great change has sprung the extensive Siemens steel industry of South Wales and Monmouthshire, producing annually hundreds of thousands of tons of open-hearth steel.

The limitation by cost of production, just referred to, is very significant. It was possible to produce at a lower cost a metal of equal quality—or equally suitable quality--with charcoal iron, but the Siemens steel-makers could not then—nor could the bessemer-steel-makers until some years later—produce a metal at a sufficiently low cost to compete with the coke bar from which was made the commoner quality of tinplate.

Similarly the steel-maker could not produce mild steel in the form of plates, angles, etc., to sell at the same price per ton as that at which the ordinary iron of commerce sells ; consequently he had to search for other advantages to offer to users, to induce them to accept his more costly material in place of the cheaper iron. These were found, and will be referred to later ; but, while fully appreciating these and urging their great value, the maker was oppressed in the early days by the necessity of reducing his costs of manufacture, so that he might compete successfully with the iron maker and increase the demand for steel. In later days it became increasingly necessary to reduce costs, in order to maintain his position in competition with other makers of steel at home and abroad.

This necessity has been the beneficial, if unpleasant, cause of many most important modifications and improvements in methods, processes, machinery, and apparatus, and has resulted in the tremendous development in the manufacture of mild steel which we have witnessed in the course of twenty years.

Twenty-five years ago the Siemens gas-producer and the Siemens melting furnace were *essentially* what they are to-day. They have been modified in form and in many details, but the principal changes have been in the direction of enlarged areas of melting hearth, of gas and air ports, of regenerator-chambers, and of gas and air flues and valves, and have resulted in a largely-increased output of ingots.

In the early days a melting furnace had a capacity of five or six tons and a weekly output of about fifty tons of ingots. The total consumption of fuel—a fairly good coal being used—was nearly sixteen hundred pounds to the ton of ingots produced. To-day charges of forty to fifty tons are common, and a weekly output of three hundred tons of ingots per furnace is by no means exceptional, while the consumption of fuel—now principally "slack" or "dross"—has decreased to nearly one thousand pounds per ton of ingots produced.

Consideration of the arduous labour of charging forty to fifty tons of material, and the time occupied in doing this by manual labour, have led to the construction of powerful and ingenious machines to relieve the workman of this serious tax on his physical strength, and simultaneously to economise in cost. On the "casting" side of the furnace the diminutive carriage and ladle of five to six tons' capacity has developed into the huge cauldron capable of containing fifty tons of steel in addition to a large portion of the accompanying slag. The ingot of ten or eleven hundred pounds for rolling into angles or sectional bars has grown to one of three or four thousand pounds or more, and those from which plates are produced have developed from about one ton to seven or eight tons or more.

To deal with these masses the three- or four-ton steam travelling cranes have been superseded by magnificent machines—steam, hydraulic, or electrical—capable of moving, with the greatest ease and facility, masses weighing fifteen to twenty tons and in some cases even fifty to sixty tons.

It was at first the custom to hammer the ingots, especially those to be made into plates. Originally an eight- or ten-ton hammer was used. The ingot usually weighed from two thousand to twenty-five hundred pounds, and was manipulated by a gang of six or eight men, who turned off fifteen to twenty tons of slabs daily. For larger plates ingots of three thousand to thirty-five hundred pounds were used; but to handle these with any degree of safety four additional men were required. These hammermen were a frequent cause of trouble to managers by their insubordination and readiness to "strike" on slight pretences, and they were a class not easily replaced.

Trouble of this character, added to the desire to make heavier slabs for larger plates, led the writer to design and construct in 1884 a "slabbing," or "cogging," mill, with suitable gear for tilting the ingot, so that "work" could be put on the edges. This first mill—since universally adopted in one form or another—was made to deal with ingots of two and a half to three tons in weight; now ingots of seven tons, and not infrequently ingots of ten tons, are in use. This step in advance was of very great importance. At the mill a few men did with ease the daily work which it had required sixty men to accomplish under the steam hammer; better slabs were made, with a much smaller proportion of scrap; and, most important of all, much larger and heavier slabs were made, thus rendering possible the production of the magnificent plates now frequently called for. An incident of this progress was the evolution of the vertical furnace—either coal- or gas-fired—from the Gjers soaking pit, which had worked for many years with fair success.

The earlier plate mills had rolls about six and one-half feet long and twenty-four inches in diameter, and were capable of rolling the slabs then made into plates as large in area as any then ordinarily used. Since the advent of the slabbing mill, however, and the evolution of the slab of six or eight tons, plate mills have been increased in size, until now the largest rolls are thirteen and one-half feet long and about forty-four inches in diameter. Simultaneously it has been necessary to improve and develop all the means of handling these masses, and of shearing and finishing the large plates referred to.

Thus cursorily we have glanced at the developments in the processes and means of manufacture. It is evident that these have been very great, and have involved the expenditure not only of vast sums of money, but of a great amount of ingenuity, energy, and skill on the part of the managers. It may almost be said that, in the course of the period under review, a new professional expert has been evolved,—the metallurgical engineer. The mark of his genius, in conjunction with that of the mechanical engineer, is evident at every point. In all the various melting furnaces, with the splendid mechanical appliances used in operating them; in the magnificent rolling mills, with their feed-roller gear, screwing gear, travelling tables, and other auxiliary appliances; in the exceedingly massive and powerful shears for measuring and cutting slabs, and for shearing plates,—are evidences that the steadily-increasing demands on the skill of the engineer have been adequately met. The development of the conceptions of the metallurgist or metallurgical engineer, and the realisation of his aims and ambitions, have effected a corresponding development on the part of the mechanical engineer and his means and appliances for the production of the machinery demanded by the circumstances in which both experts found themselves. In fact, the action has been reciprocal; the ideas of both have been enlarged, and both have been enabled to control forces and powers which have rendered possible operations and results undreamed of a quarter of a century ago. A measure of the development of the production of "mild steel" may be found in the following figures, which give the output of open-hearth steel ingots in Great Britain in the years stated, the very great and constant increase of this output being due to the development in the demand for "mild steel."

1877	150,000 tons.	1887	981,104 tons.
1878	160,000 "	1888	1,292,742 "
1879	175,000 "	1889	1,429,169 "
1880	251,000 "	1890	1,564,200 "
1881	338,000 "	1891	1,514,538 "
1882	436,000 "	1892	1,418,830 "
1883	455,500 "	1893	1,456,325 "
1884	475,250 "	1894	1,575,318 "
1885	583,918 "	1895	1,754,737 "
1886	694,150 "	1896	2,317,555 "
		1897	2,601,806 "

These figures are principally taken from *The Iron & Coal Trades Review*, August 19, 1898.

The "new departure" taken by Sir N. Barnaby on behalf of the British admiralty—as previously described—has been consistently followed to the present time. The broad views that he entertained, and the very intelligent lead and encouragement that he gave to the steelmaker, have been ably seconded by his esteemed and powerful successor, Sir Wm. White. It is probably correct to say that every vessel constructed for the royal navy since that time has been built almost entirely of steel. The same may be said, of course, of vessels built for foreign governments, which have drawn on the steelmakers of Great Britain for a very large proportion of their requirements.

In some notes furnished to the writer by Sir N. Barnaby he says: "The modern ship . . . has at the same time availed itself of every advance in the improvement of iron or, or in other words, in the substitution of steel for iron. Engines are steel, boilers are steel, the hulls and the armour of the ships are steel, and so also are the guns and the projectiles. This vast change has come about since the Iris and Mercury were built for the British navy twenty years ago. The prime agent in it, Sir Wm. Siemens, is dead. The men who were foremost in appropriating the new material and making the most of its qualities are still among us. It is to Thornycroft, Yarrow, and Normand, to Schnieder and to Krupp, that engineers and gunners are mainly indebted for the initiative in the use of steel for naval warfare."

When, however, attention is turned to the mercantile marine,—to the building of ships for the merchant navy,—other elements enter into consideration. Before there could be any great development in the use of "mild steel" in this direction, it was necessary to remove the objections, to overcome prejudices if any existed, and to satisfy the requirements of three important parties concerned therein. These were the ship owners, the ship-builders, and—perhaps most important of all—the surveying and other authorities—the committees of Lloyds Registry and of the Liverpool Underwriters' Registry, then two separate corporations, but since amalgamated.

To take the last first, it is well known that, before a vessel can be classed at "Lloyds," the plans must have had the approval of the committees; they must conform to the requirements in every detail, whether as to material, scantling, or structure. Hence the importance of the acceptance of the "new material" by these authorities, and under conditions favourable to its use. As has been shown, the admiralty had, in 1875, contracted for the material for the construction of two vessels, and in 1876 the very satisfactory results obtained were made known at the meetings of the Institution of Naval Architects. Notwithstanding these circumstances, it was not until nearly two years later that "Lloyds" announced their conclusions as to their requirements when steel was used in the construction of vessels. In the interval a committee of principal officials visited most of the steel works, inquiring into the methods of manufacture, and critically investigating the characteristics and behaviour of the metal under varying treatment and conditions. Then came the decision, which, remembering the intelligent views always held by the chief surveyor, Mr. Martel, was what might have been expected. Having regard to the admirable character of the material and its superior tensile strength, a reduction of about twenty per cent. would be allowed in the scantlings of the structure. An organisation was eventually arranged by which surveyors were to witness the testing of the steel at the maker's works, and to certify that it had met all the requirements of the committee.

The ship-builders, as a whole, were slow to adopt the new material. Possibly they had apprehensions of difficulties in its use; certainly most of them failed to realise that they had any interest in recommending it to their clients, and in most cases they were apathetic. There were several brilliant exceptions to this rule, however,—the late Mr. Wm. Denny, the late Dr. A. C. Kirk, Mr.—now Dr.—John Inglis, the Thomsons of Clydebank fame, with Mr.—now Professor —J. H. Biles, who had been associated with the use of the material in building the Iris and Mercury and afterwards held a principal position at Clydebank. These men recognised the great possibilities which the new material opened to the naval architect, the ship-builder, and the engineer, and were insistent on its adoption and favourable treatment by the different registries. But, as has been said, the ship-builders, as a whole, were indifferent.

In these circumstances the steel-maker decided to turn to the ship-owner, to show him that his interest lay in having his ships built of steel instead of iron. In the early days very little headway was made; the disparity in the cost of the two materials was too great. Such vessels as were built were of special character and for special purposes,—the well-known Columba of the Clyde, two steamers for cross-channel service, torpedo boats, barges, and other vessels for Indian rivers, etc. When, however, the steel-maker had to some extent succeeded in reducing his cost of manufacture, and could thus sell at a price approaching more nearly that of iron; when Lloyds sanctioned the reduced scantlings, thus further reducing the total cost of the steel vessel; when it could be demonstrated that, although it might be more costly, the steel vessel was a much safer and better vessel, and that it had a larger carrying-capacity on the same displacement, and therefore a larger earning power,—then, slowly but surely, conviction entered the minds of the ship-owners, and the steel-makers' victory was in sight. It was arduous work, but it extended over only a few years. When one famous line after another—the Union Steamship Company, of New Zealand, the Pacific Company, the Allan Company, the Castle Company, the British India Company, the P. & O. Company, the Cunard Company, in the sequence here given and in the course of the years 1878 and 1879—ordered vessels of the new material, an influence was brought to bear which proved irresistible. It began to be realised that, if business connections were to be retained, and if work was to be carried on economically, vessels of the new material must be obtained.

Then also came enlightenment to the ship-builders. Soon they found themselves engaged in a movement of vast importance. They were entering upon an era of prosperity such as they had not anticipated. Not only so, but, when they began to work and use the new material, they found possibilities that promised a long continuance on the line of progress on which they had entered. They found very few of the anticipated difficulties in working steel; on the contrary, they had so few failures when compared with those they had when using iron that both workmen and employers found it more remunerative and economical to use steel, especially in difficult work. More than this, the ship-builder, after conferring with the steel-maker, found that he could burst the bonds in which he had been held by the natural restrictions on the powers of the ironmaster. Gradually, but surely, new or larger or more economical sections were asked for and furnished, and plates of larger area and weight were produced. Whereas in the early days plates sixty feet in superficial area were looked upon as of considerable size, in these days it is possible to obtain them of quite four times that area. As these facilities gradually became available, and he developed his own machinery to deal with these larger and heavier pieces, the ship-builder found that he could largely increase his output in a given period, and diminish the cost in handling, in rivetting, and in many other directions,—in fact, could produce a vessel at a much lower cost than was possible in the old days.

The large increase in demand, and the constant effort to improve his methods of manufacture and his mechanical appliances so as to satisfy the incessant new requirements, resulted in the present advanced stage of progress, and in the ability to sell these fine products at about one-fourth the price paid in 1875 for the small sections and plates which it was then possible to supply.

But, if the ship-builder found his advantage in the use of the "new material," the marine engineer discovered possibilities in which he could fairly revel. "Cribbed, cabined, and confined" by the limitations placed upon him under the old *régime*, he could now indulge the hope of gratifying his highest aspiration, of realizing conceptions which of yore it seemed almost madness to entertain. Having at his command a material on whose good qualities he could absolutely rely, and which he could obtain in sizes hitherto undreamed of, he gradually evolved that tremendous instrument, the marine boiler of the present day. Desirous of meeting his utmost demand, the steel-maker has supplied the engineer with plates three hundred feet in area and two inches in thickness, proved of uniform and reliable character throughout. Possessed of these, the engineer has, with the utmost confidence, produced a boiler capable of enduring the highest pressures, and has thus been able to take step after step in advance,—to develop the quadruple-expansion engine after having successfully launched the triple-expansion one, and to approach very closely to his ideally-perfect, economical engine.

But in the marvellous triumphs of marine engineering of these latter days are to be found other evidences of the beneficial results of the interchange of ideas between the marine and metallurgical engineers, without which, in fact, these achievements could scarcely have been accomplished. Very tentatively, twenty years ago, the manufacture of steel castings of the new "mild" character was commenced and carried on. With lengthened experience, confidence in his power of production was developed in the steel-founder, and in the mind of the engineer a like confidence in the use of steel castings. The demands of the engineer steadily grew in number and in difficulty, but each step in advance was carefully made and firmly held, until the steel-maker has given the engineer castings—almost equal to forgings in quality—of twenty to thirty tons in weight, of what may be called enormous dimensions, and of most intricate character. Able to obtain soleplates, columns, etc., of such magnitude and character, the contruction of engines like those of the Paris and New York, the Campania and Lucania, has been rendered possible, or at least much less difficult than would otherwise have been the case, while in other cases the number of pieces has been much reduced, the designs have been simplified, and the cost has been diminished.

	Iron.	Steel.
1877	443,015 tons	nil
1878	517,692 tons	4,470 tons
1879	470,969 tons	16,000 tons
1880	459,994 tons	35,373 tons
1881	659,153 tons	71,533 tons
1882	851,075 tons	125,841 tons
1883	933,774 tons	166,428 tons
1884	661,201 tons	132,457 tons
1885	303,825 tons	162,641 tons
1886	189,854 tons	191,399 tons
1887	94,512 tons	380,570 tons
1888	62,612 tons	687,235 tons
1889	78,609 tons	1,016,071 tons
1890	42,069 tons	957,894 tons
1891	35,846 tons	1,092,244 tons
1892	29,859 tons	1,059,001 tons
1893	7,181 tons	780,085 tons
1894	10,430 tons	893,856 tons
1895	7,789 tons	862,595 tons
1896	10,407 tons	908,304 tons
1897	9,206 tons	763,766 tons*

TONNAGES (GROSS REGISTER) OF IRON AND STEEL VESSELS BUILT UNDER SURVEY OF LLOYD'S SURVEYORS DURING THE YEARS 1877 TO 1897, INCLUSIVE.

Conjointly, then, the ship-builder and engineer have, in the end, availed themselves to the fullest extent of the services of the steel-manufacturer. They have made such use of "mild steel," and it has been obtained at such prices, that it has been almost universally adopted as the best and cheapest material for the construction of ships and their boilers and engines. The rate of development in its use for this purpose may to some extent be measured by the table on the preceding page which gives the tonnages of vessels of iron and steel "classed at Lloyds" in the years named.

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*Engineers' strike; 1898 will shew a large gain.

These figures are sufficiently startling in themselves, but they mean a great deal more than is at once evident. A new industry—the manufacture of "mild steel"—has been created, and developed to an enormous extent. This, in turn, has rendered possible the construction of the magnificent vessels of the present day, propelled at railway speeds by the marvellous modern marine engine, at the lowest cost in expenditure of fuel. In these achievements are embodied the results of active and influential interchange of ideas between the metallurgical, the marine, and the mechanical engineer, at every stage, nay, at almost every step in the progress made.

But the results do not end here. The whole social condition of the people has been improved by the abundance of employment; by the cheapening of the necessaries of life brought from the ends of the earth at costs undreamed of in the past, but rendered possible by the achievements under consideration; by the facilities and comfort of present-day travelling; and, may we not also add? by the growth—intellectual and moral—due to these improved conditions and the education of all the powers necessarily possessed by those engaged in these noble pursuits.

The development of the use of "mild steel" has not been confined to ship-building and marine engineering. In the realms of the mechanical and civil engineer it has been equally conspicuous. After the board of trade, in 1878, allowed the co-efficient of strength of steel for structural purposes to be taken at six and one-half tons, as compared with five tons for iron, its use in the construction of bridges rapidly extended, the most conspicuous example of its application being that of the Forth Bridge, rendered possible by the judicious and intelligent use of the "new material" by its eminent designers.

In view of these applications, as well as those of the builder of locomotives and rolling stock, and innumerable other requirements, it is not a matter of wonder that the manufacture of steel has developed to the extent indicated by the figures given above, justifying the sentence used at the commencement of these articles,—*viz.*, that this may be fairly called "The Age of Steel," of which the manufacture and use of "mild steel" forms a striking feature.

A SIMPLE AND EFFECTIVE SYSTEM OF SHOP COST-KEEPING.

By H. M. Norris.

THE system of accounting governing the collection, tabulation, and retention of the cost of an article of merchandise plays so important a *rôle* in the commercial organization of so many industrial enterprises that it does, indeed, seem strange that so few representative concerns are in possession of really reliable knowledge of the subject. Of all the elements which enter into and contribute toward the success of a business, the subject of cost-keeping is least understood. Systems there are galore, but how much confidence can be placed upon the figures derived from one out of ten? Every man makes use of that system which, in his judgment, seems best adapted to the needs of the establishment over which he has authority. But in matters of this nature a man's judgment is very apt to be at fault, especially if he is not a graduate from the shop. Here and there a manufacturer knows what he is doing, but the multitude are foundering in a sea of uncertainty and perplexity, from which there can be no relief until the subject receives the attention it deserves.

Mr. Henry Roland's many valuable contributions on this subject to THE ENGINEERING MAGAZINE afford a rare opportunity for the study of the practice followed by many leading firms, and contain much of interest to every one connected with shop management. His incisive drawing of the difficulties to be met and overcome in the reorganization of an old and well-established business will strike home to the hearts of many managers. If proprietors could be brought to a better understanding of what a strong organization would mean to them, the work of the manager would be much simplified.

It is the object of this paper to describe a system of cost-keeping which, for simplicity and effectiveness, meets the requirements of the shops of which I have had charge better than any other system of which I am cognizant.

There are a number of ways by which the cost of a machine, as a whole, can be obtained with a reasonable degree of accuracy, and many manufacturers are satisfied with this amount of information. But it is not enough for the progressive manager. A knowledge of the total cost of a machine is of use only in fixing the selling-price, or in taking an inventory. It is of no practical value in reducing cost. The information is too general. The foreman has no means of detecting excessive time, except through his own observation. Tell him that a certain machine cost two hundred dollars more than the last one, and he is baffled at once. He does not know where to fix the responsibility, nor is there any way in which he can find out. It is impossible to reduce the cost of a machine to its minimum figure without first obtaining an accurate knowledge of the time consumed in the manufacture of each piece. A workman will not exert himself without an object. He must be offered some incentive. The piece-work, premium, and differential systems are conducive to this end, but should be used after, and not before, the acquisition of reliable time-records. To ally the time of one man with that of another is to halve the responsibility of each. It promotes laziness and destroys ambition, and is a practice to be avoided when possible. Every man should be permitted to make his own record, untrammeled by the time of another. Each should be paid according to his ability.

This means that it is necessary not only to keep track of the cost of each piece on a machine, but to ascertain the cost of every operation on each piece. It is, therefore, obvious that we must adopt some form of job ticket.

A separate ticket for each operation would necessitate the filling out of from one to six or more forms for each piece on the machine,—a procedure involving an immense amount of clerical labor, not only in preparing the tickets for the shop, but in collecting and tabulating the results for ready reference in the future. Hence we must find some other means of accomplishing the desired results.

The system should give three things,—the time required on each operation, the prime (or flat) cost of each piece, and the total cost of the machine as a whole. The first furnishes the necessary information for the reduction of cost, the second the means of determining the price at which repairs can be furnished, and the third the selling-price of the machine proper. The question now is: What is the cheapest, quickest, and most reliable way of obtaining this information?

The manager's desk should be the Alpha and Omega of every transaction. It should also be the information bureau of the establishment. No work should be done without the manager's authority and sanction. He should be posted in all things relative to the various stages of the work in operation, and the knowledge should be reliable and easy of access. A large plant requires a more elaborate system than does a small one, but the principle of the one is the principle of the other. In a small shop an order can be issued to its ultimate destination at once, while in a large one it may be desirable to have it pass through the hands of the works manager, superintendent, or stock clerk—a difference in detail only.

Starting, now, from the manager's desk, let us note the various objects to be attained by the system. The store keeper must receive authority to order castings and other necessary merchandise. The foreman must be notified when the material is in stock ready for the shop. The workman must have authority to remove the material from stores. The foreman must know what work has been finished, and what remains to be done. The job clerk must know what material is used on each order, the time consumed in the performance of each operation, and the total cost of each at any stage in the progress of manufacture, all of which can be accomplished by the thoughtful use of the collective job, or "piece order," ticket.

I have near my desk a board, twelve inches by twenty-two, containing twice as many pins as there are sizes and styles of machines in my line of manufacture. Two pins are used for each machine, one above the other. On these are hung poker chips of different colors, as shown in Fig. I. When an order is issued to the shop, red chips, equal in number to the machines called for on the order, are placed on the upper pin devoted to the machine ordered, and, as each machine is completed and goes into stock, one chip is taken off and hung on the lower pin. For every order that is received, a blue chip is placed on the lower pin, which, together with a red one, is removed when the machine is shipped. If no machines of a certain kind are being made, the pins remain bare, except where the manufacture of that machine has been discontinued, in which case a white chip is hung on both the upper and the lower pin. When a pair of pins have six red chips on the upper one and three red ones and one blue one on the lower, it signifies that there are six machines in the course of erection, three in stock, and one sold, awaiting shipment.

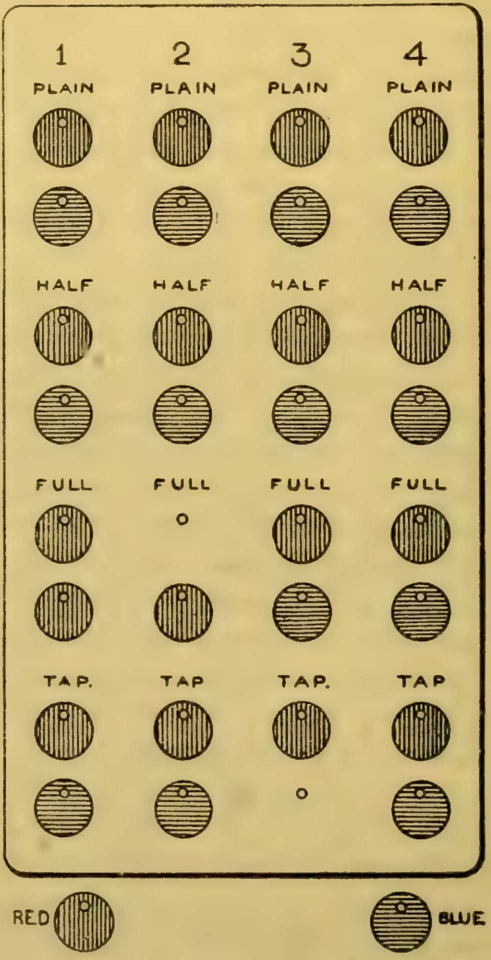
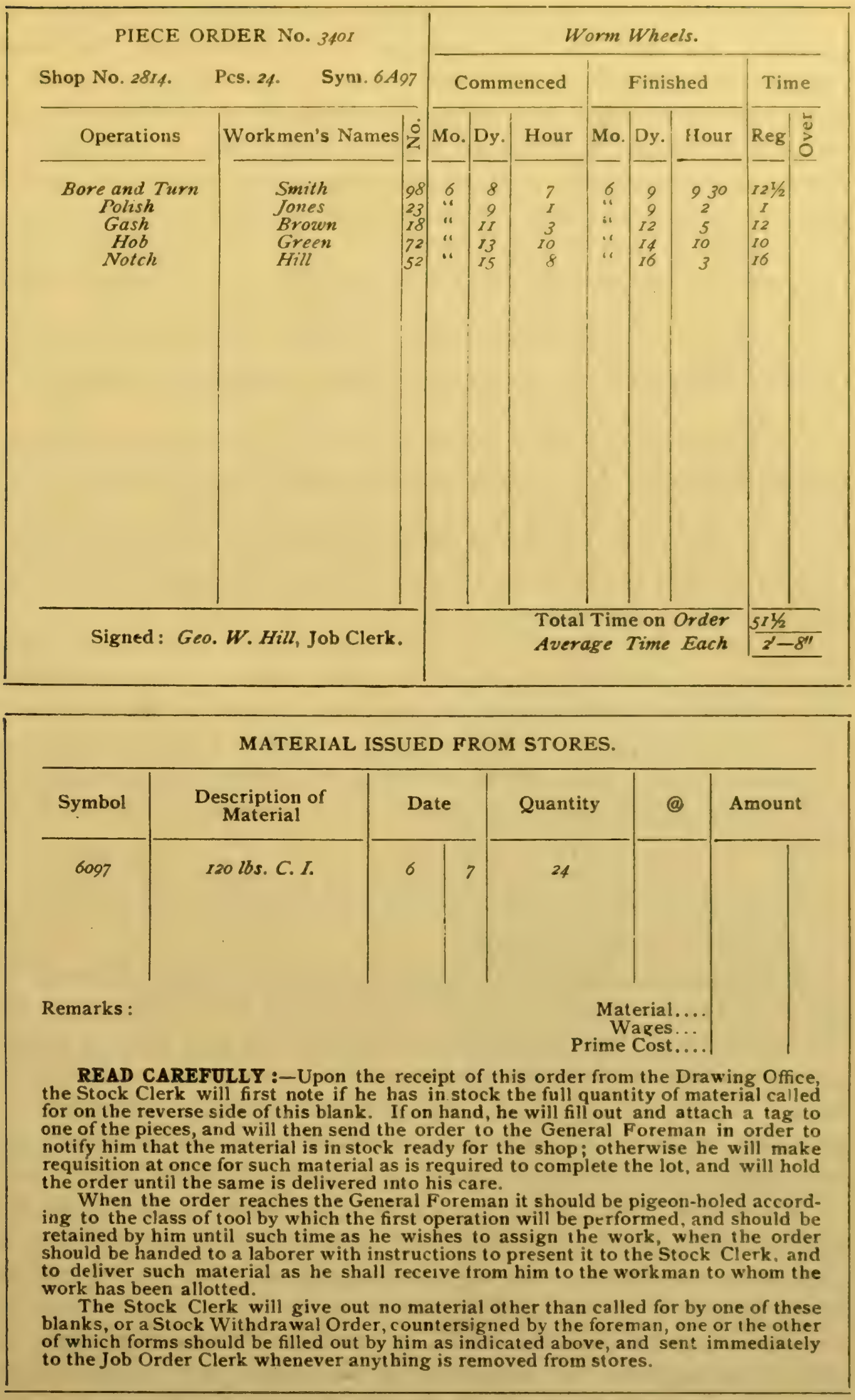


FIG. I.



PIECE ORDER No. *3401* — *Worm Wheels.*

Shop No. *2814.* Pcs. *24.* Sym. *6A97*

			Commenced			Finished			Time	
Operations	Workmen's Names	No.	Mo.	Dy.	Hour	Mo.	Dy.	Hour	Reg	Over
Bore and Turn	*Smith*	*98*	*6*	*8*	*7*	*6*	*9*	*9 30*	*12½*	
Polish	*Jones*	*23*	"	*9*	*1*	"	*9*	*2*	*1*	
Gash	*Brown*	*18*	"	*11*	*3*	"	*12*	*5*	*12*	
Hob	*Green*	*72*	"	*13*	*10*	"	*14*	*10*	*10*	
Notch	*Hill*	*52*	"	*15*	*8*	"	*16*	*3*	*16*	

Signed: *Geo. W. Hill,* Job Clerk.

Total Time on *Order* *51½*
Average Time Each *2'—8"*

MATERIAL ISSUED FROM STORES.

Symbol	Description of Material	Date		Quantity	@	Amount
6097	*120 lbs. C. I.*	*6*	*7*	*24*		

Remarks:

Material....
Wages...
Prime Cost....

READ CAREFULLY :—Upon the receipt of this order from the Drawing Office, the Stock Clerk will first note if he has in stock the full quantity of material called for on the reverse side of this blank. If on hand, he will fill out and attach a tag to one of the pieces, and will then send the order to the General Foreman in order to notify him that the material is in stock ready for the shop; otherwise he will make requisition at once for such material as is required to complete the lot, and will hold the order until the same is delivered into his care.

When the order reaches the General Foreman it should be pigeon-holed according to the class of tool by which the first operation will be performed, and should be retained by him until such time as he wishes to assign the work, when the order should be handed to a laborer with instructions to present it to the Stock Clerk, and to deliver such material as he shall receive from him to the workman to whom the work has been allotted.

The Stock Clerk will give out no material other than called for by one of these blanks, or a Stock Withdrawal Order, countersigned by the foreman, one or the other of which forms should be filled out by him as indicated above, and sent immediately to the Job Order Clerk whenever anything is removed from stores.

FIGS. 2 & 3. FACE AND REVERSE OF ORDER TO JOB CLERK.

By this means I can tell at a glance just how many machines of each kind are in stock, how many more are in building, and what number of each are sold. If I find the stock is running too low on a certain size, I issue an order to the job clerk for a new lot, who, in turn, issues as many of the piece orders shown in Fig. 2 as there are pieces on the machine,—*i. e.*, pieces upon which work is performed specially for this machine. The job clerk merely fills in the shop number, the number of pieces required to fill the order, and the symbol—pattern-mark—of the piece, the dotted line at the right being used only for irregular work having no pattern or stock number. This done, the piece orders are sent to the stock clerk, who carries out the instructions printed at the bottom of the reverse side of the ticket (Fig. 3).

In many cases the same piece is used on a number of different sizes of machines; so, in order to insure the making, at one time, of as many like pieces as will be used on the total number of machines on order, the stock clerk keeps the piece orders on file, arranged according to their symbols, card-index fashion, until such time as he receives the full quantity of material called for by all duplicate piece orders, which are then massed into one order, calling for as many pieces as were wanted for each of the other orders. In other words, if the stock clerk finds that he has two piece orders for the same part, one for six pieces and one for twelve, he holds both until he has eighteen pieces in stock, when he writes out a new piece order calling for eighteen pieces, designating how many are wanted for each shop order.

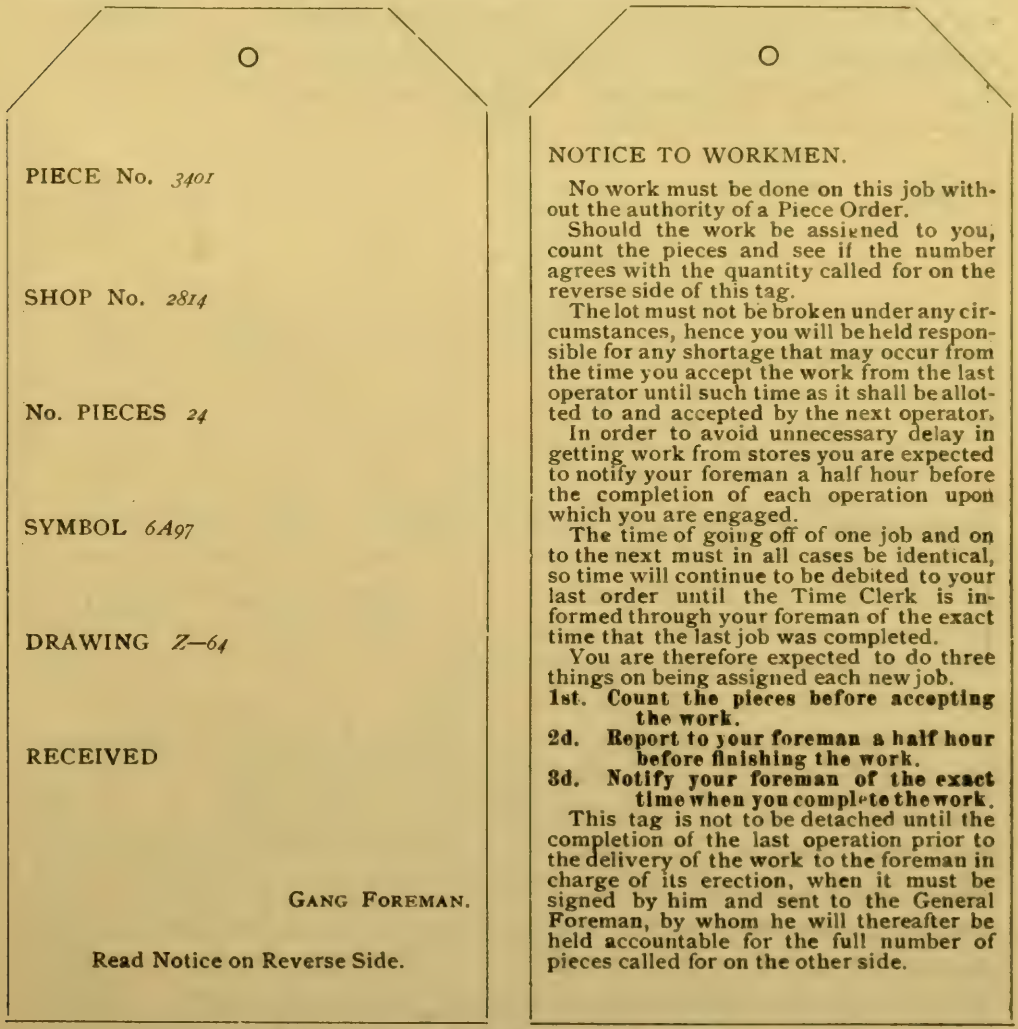
By running over the piece orders in his possession once or twice a week, the stock clerk can readily detect just what stores are needed to complete all orders in hand.

It frequently happens that, while there may be plenty of work in the shop, the foreman is at a loss to know what work to assign to the various hands as they come to him for a new job, and finds it necessary to do considerable looking around before he is able to find anything. But, by filing the piece orders according to the instruction on the backs of the tickets, this delay is entirely avoided, as he can see at a glance just what work there is to be turned, planed, milled, etc.

After each ticket has been returned to the stock clerk, and the work counted, weighed, tagged, and turned over to the shop, it is sent to the job clerk, who, after noting whether the proper entries have been made on the back, places it on file in a trough similar to the one in use in the stock room, but made in two compartments, to distinguish between the tickets in use and those partly finished but not being worked upon at the time. Here the tickets are kept according to their piece-order numbers, instead of their symbols, as was the case in the stock room.

Now we come to that part of the system concerned with the getting of the men's time upon the tickets. I have tried four ways. The first was to have the time clerk go among the men every morning, and take such time as they gave him. The second was to have each of the men hand his time in on a slip every evening, as he quit work. The third was to have the men report to the job clerk every time they started a new job. The fourth is the plan I am now using.

No work is permitted to leave the store room without a tag (Fig. 4), which practice simplified the problem considerably, and avoided the everlasting running to the foreman to ask: "What shall I charge my time to?" The tagging did not, however, prevent errors from creeping into the figures collected by the first two methods. Unless a workman is fairly good in mental arithmetic, it is a troublesome prob-



PIECE No. *3401*

SHOP No. *2814*

No. PIECES *24*

SYMBOL *6A97*

DRAWING *Z—64*

RECEIVED

GANG FOREMAN.

Read Notice on Reverse Side.

NOTICE TO WORKMEN.

No work must be done on this job without the authority of a Piece Order.

Should the work be assigned to you, count the pieces and see if the number agrees with the quantity called for on the reverse side of this tag.

The lot must not be broken under any circumstances, hence you will be held responsible for any shortage that may occur from the time you accept the work from the last operator until such time as it shall be allotted to and accepted by the next operator.

In order to avoid unnecessary delay in getting work from stores you are expected to notify your foreman a half hour before the completion of each operation upon which you are engaged.

The time of going off of one job and on to the next must in all cases be identical, so time will continue to be debited to your last order until the Time Clerk is informed through your foreman of the exact time that the last job was completed.

You are therefore expected to do three things on being assigned each new job.

1st. Count the pieces before accepting the work.

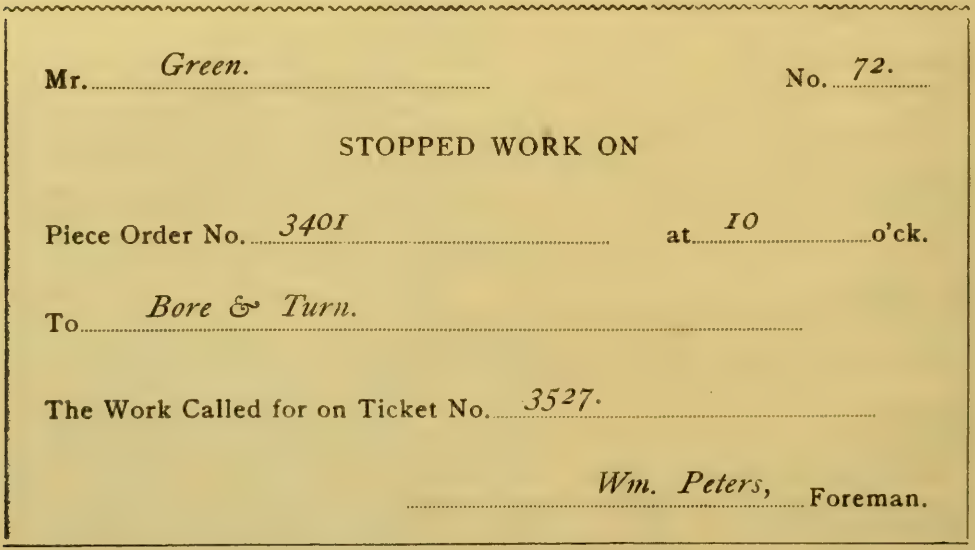
2d. Report to your foreman a half hour before finishing the work.

3d. Notify your foreman of the exact time when you complete the work.

This tag is not to be detached until the completion of the last operation prior to the delivery of the work to the foreman in charge of its erection, when it must be signed by him and sent to the General Foreman, by whom he will thereafter be held accountable for the full number of pieces called for on the other side.

FIG. 4. FACE AND REVERSE OF STORE-ROOM TAG.

lem for him to figure elapsed time between two given periods in the day, especially when one period is A. M. and the other P. M. and the noon-interval is a fractional part of an hour. The men not only spent a great deal of time in the calculations, but the results were not reliable. Sometimes they would forget to look at the clock to note the time of commencing a job. At another time they would get hold of the wrong order number. Again, they would juggle their time in order to hide some bad workmanship, or to guard against being "jumped on" for spending too much time on certain work. The third plan, in which all figuring is done by the job clerk, overcame most of these difficulties, and would have proved satisfactory, had we had a job clerk on each floor; but, as it was, it gave the men an opportunity of doing too much visiting while on their way up and down stairs. My fourth, and present, plan is practically the same as the third, except that, instead of having the men report to the job clerk each time they start a new job, I have them report to the department foreman, each of whom carries a pad of time-slips printed as shown in Fig. 5. These slips are used in the following manner.



Mr. *Green.* No. *72.*

STOPPED WORK ON

Piece Order No. *3401* at *10* o'ck.

To *Bore & Turn.*

The Work Called for on Ticket No. *3527.*

Wm. Peters, Foreman.

FIG. 5. TIME SLIP.

As soon as a man completes each job, he says to his foreman: "I finished the work on piece order No. 3401 at 10 o'clock." The foreman says to him: "Bore out that job of cones lying on the floor near your machine," the piece-order number of which he noted on a blank slip a half-hour earlier, when the man first notified him, in accordance with the instructions on the back of the tag, that he would shortly be out of work, and prior to his sending the piece order to the stock clerk to have the castings delivered from stores. Turning to this slip, the foreman fills it out as shown in the illustration, and both his and the man's clerical work is completed. These tickets, besides removing all time-keeping from the hands of the workmen, and accomplishing their mission so far as it relates to the time records in the office, furnish a check on the foreman, as any delay in getting work to the men will appear in the time charged against the job.

On reaching the office each morning, the slips are first assorted according to the men's numbers. Then, beginning with number one, the time is transferred to the piece orders and to the time book at the same time.

TIME SHEET.

Name of Workman, *Sam Hill.* Check No. *52.*

	Ordinary Time.										Overtime.										Total.	
Order Number	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Total.	Rate.	Amount debited to job.		Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Total	Rate.	Amount debited to job.	Time.	Amount of wages payable.
2310	*10*	*2*					*12*	*20*	*2*	*40*												
2572		*8*	*4*			*3863*	*12*	"	*2*	*40*												
2118			*5*				*5*	"	*1*	*00*												
2417			*1*	*7*			*8*	"	*1*	*60*												
2219				*3*	*10*	*8*	*21*	"	*4*	*20*												
Totals	*10*	*10*	*10*	*10*	*10*	*8*	*58*		*11*	*60*												

Week ending *Aug. 27th, 1898.* Examined, *W. E. Cole*, Timekeeper.

FIG. 6. TIME SHEET. THE ORIGINAL HAS LINES FOR 28 ORDER NUMBERS.

This book (Fig. 6) answers a triple purpose. A separate page is used for each workman, and a separate book for each week if the shop is running over-time (for two weeks in ordinary time, when the right half of the sheet is used for ordinary time, like the left side). The totals at the bottom of the vertical columns act as a check between the sum of the hours charged each day to the whole number of tickets upon which each man has worked and the records furnished by the time clock, both of which must agree before the time is entered upon the piece orders. The small figures, 3863, near the top of the sheet show the number of the piece order upon which the man is at work, and furnish a means of checking the correctness of the entries on the time-slips. The horizontal lines show the total number of hours and amount of wages to be debited each week to the respective shop numbers, which figures are carried directly to the prime cost book, a page of which is shown in Fig. 7. This book is merely a book of totals, and requires no explanation beyond mentioning that the numbers above and below the order number refer to the number of the page, back or forward, from or to which the number was or is carried. This completes all work connected with the gathering of the prime cost, but, before passing to the next branch of the subject, it may be well to review the entire system to this point.

PRIME COST BOOK.

Bickford Drill & Tool Co. Month of *December*, 1897.

Order Number.	Date	Drawings			Patterns		Material		Sundries		Machine Work			Total			Remarks
		Hrs	Am't		Am't		Am't		Am't		Hrs	Am't		Hrs	Am't		
Forwarded		*70*	*28*		*20*									*70*	*48*		
672	*4*	*50*	*20*		*35*		*6*							*50*	*61*		
	11	*30*	*12*		*18*		*12*				*8*	*1*	*60*	*38*	*43*	*60*	
2464	*18*				*12*		*8*		*2*		*20*	*3*	*60*	*20*	*35*	*60*	
	25						*3*				*65*	*12*	*35*	*65*	*15*	*35*	
684	*31*										*80*	*13*	*60*	*80*	*13*	*60*	
Totals		*150*	*60*		*85*		*29*		*2*		*173*	*31*	*15*	*323*	*217*	*15*	Finished
Forwarded																	
672	*4*																
	11																
2465	*18*																
	25																
684	*31*																
Totals																	Finished
Forwarded																	
Totals																	Finished

FIG. 7. REDUCTION OF ONE-HALF PAGE, PRIME-COST BOOK.

Upon receipt of my order for a lot of machines, the job clerk fills out the requisite number of piece orders. These are sent to the stock clerk, who, if he has the material on hand, forwards them at once to the general foreman. Here they are pigeon holed until the work is assigned. They are then sent back to stores, the material is issued to the shop, and the tickets are returned to the job clerk. The piece orders are thus made to accomplish seven distinct objects before being put into use as time-recorders. They furnish the necessary authority to the stock clerk to order material. Their receipt by the general foreman tells him that the work is in the house, ready for assignment. Their delivery to a department foreman indicates the order in which the work is to be gotten out. Their stay in the hands of the department foreman shows him just what work he has ahead. Their return to the stock clerk authorizes him to issue the material to the shop. Their appearance in the drawing-room shows that the work has been taken out of stores. And their location in the job clerk's file signifies whether or not the work is actually in hand. The stock clerk files them by symbol, the foreman by operation, and the job clerk by the printed piece-order numbers.

Whenever any of the foremen change a workman from one job to another, they note on their time-slip the man's name and number, the number of each piece order, the time the change was made, and the operation to be performed on the new work. These slips are left intact on their pads until the following morning, when they are sent to the job clerk, who, after assorting them by the men's numbers, transfers the time to the piece orders and to the time book, and from the latter to the prime cost book.

By looking at the time book, the job clerk can tell what work is being done by every man in the shop, and, after a little experience, becomes so familiar with the length of time required to perform a certain operation that the workmen are likely to hear from the foreman whenever they begin to drop behind on their work.

As soon as all the operations on a piece order are completed, the tag for that work is sent to the job clerk, who abstracts the order from his working file, and places it in a permanent file where all finished orders are kept, according to their symbols. So, if he is ever in doubt about the length of time a certain job ought to take, he can turn to the symbol number, and find the record on as many pieces as have been made since the system was put into practice.

We now come to the consideration of the general expense account, the scarcity of a definite knowledge upon which subject, together with the lack of a proper and comprehensive understanding of its importance, has caused a greater number of failures in business, and more unfair competition, than can be charged to any other one factor of inefficient management. To cite a case from my own experience: I was once called to the general managership of a large and apparently successful business. Not being familiar with the method of figuring, I asked the superintendent to make a certain estimate for me. He figured so much for labor, so much for material, fifteen per cent. for general expense, and fifteen per cent. for profit. I asked if he felt sure that fifteen per cent. would cover general expense. He answered that he was not sure, but that it was the figure used by "So and So," who had certainly been in business long enough to know what they were about. It was a month or two before I was able to collect any reliable data; but I was not surprised when I found that the general expense was more than two hundred and fifty per cent.

The company passed into the hands of a receiver two months later,—the inevitable result of doing business on a false basis.

The term "general expense" is intended to include every output, of whatever nature, that is not directly chargeable to some specific order number, and in my system comprises twenty-six distinct main charges, as shown in Fig. 8. I say *main* charges, as it is often desirable to separate one or more of the items into a number of smaller divisions, as, for instance, the item V, for perishable tools. V1 can be made to stand for drills, V2 for reamers, V3 for taps, etc. These reports are made monthly, and are the barometers of the business.

DISTRIBUTION OF PLANT CHARGES

for month of

Hourly Burden *21½* Cts. *June* Per Cent. Ratio *1.05* %

Assets.	A	Standard Drawings	*21*	
	B	Standard Patterns	*65*	
	C	Standard Machinery and Tools	*166*	
	D	Special Tools, Jigs, and Fixtures	*97*	
	E	Line Shafting and Accessories	*4*	
	F	Office and Shop Fixtures	*5*	
	G	Belting	*42*	
	H	Miscellaneous		
		Total	*400*	
General Expense.	I	Advertising	*399*	
	J	Office Supplies	*2*	
	K	Traveling Expenses		
	L	Drayage, Freight, and Expressage	*281*	
	M	Boxing and Crating	*30*	
	N	Interest and Discounts	*59*	
	O	Bad Debts and Extras		
	P	Official Salaries	*575*	
	Q	Rent, Power, Taxes, and Insurance	*295*	
	R	Interest and Deterioration	*600*	
	S	Interest on New Assets	*12*	
	T	Patents and Royalties		
	U	Light and Heat		
	V	Perishable Tools	*216*	
	W	Shop Supplies	*214*	
	X	Drawing-Room Supplies	*5*	
	Y	Non-productive Labor	*645*	
	Z	Miscellaneous	*279*	
		Total	*3612*	
		Average daily expense for *26* days	*138*	*92*
		Total productive labor for *16800* hours	*3440*	

FIG. 8. DISTRIBUTION OF PLANT CHARGES.

Referring to the illustration (Fig. 8), it will be seen that, of the total amount paid out during the month, only $3,440 went into work for which there is any compensation. The return for this work must, therefore, be sufficient to cover the wages paid to producers, plus the sum of all other outlays, amounting to $3,612 = wages plus 1.05 per cent. of wages. In other words, $2.05 must be received for every dollar charged to productive labor before we so much as meet bare expenses. This, however, is not the best basis upon which to make our calculations, as it makes the charge for boys' time far too low, and that for good men's time too high. It is much better to follow the hourly-burden plan described by the writer in Vol. XIX of the *Transactions of the American Society of Mechanical Engineers*, from which the following illustration is taken :

3 hours at .10 =	$ .30
6 " " .15 =	.90
9 " " .20 =	1.80
12 " " .25 =	3.00
30 hours	$6.00
General Expense,	6.00
Actual Cost,	$12.00

Col. 1.	Col. 2.	Col. 3.
3 × .40 = $ 1.20	.30 + 100% = $ .60	3 × .20 + .30 = $ .90
6 × .40 = 2.40	.90 + 100% = 1.80	6 × .20 + .90 = 2.10
9 × .40 = 3.60	1.80 + 100% = 3.60	9 × .20 + 1.80 = 3.60
12 × .40 = 4.80	3.00 + 100% = 6.00	12 × .20 + 3.00 = 5.40
$12.00	$12.00	$12.00

"Suppose the total charge against a certain job amounted to $6, consuming thirty hours' time as above, and that the cost of running expenses for that length of time is $6 more; then $12 is the amount which we must receive for the work, exclusive of all profit. Figuring on the old basis of a fixed charge per hour (Col. 1), we have $12 ÷ 30 = 40 cents as the rate per hour at which each item must be charged to net $12 on the job as a whole. Figuring on the basis of wages plus a certain percentage of wages (Col. 2), we have $6 ÷ $6 = 100 per cent., as the percentage by which each item of wages must be increased to meet general expense and net the $12 necessary to cover costs. Figuring, lastly, on time multiplied by the general expense per hour plus wages (Col. 3), we have $6 ÷ 30 = 20 cents as the amount per hour which must be added to each item to make the $12. Comparing the last two methods, the first being unworthy the name, we note that, while the second system of figuring accomplishes its mission so far as the ultimate results are concerned, it is manifestly inferior to the third plan, in which expenses are made on every hour of labor, irrespective of the rate per hour of the workmen, —the loss on cheap labor by the second plan not having to be made good by overcharging for the work of those requiring greater skill."

The hourly burden for any month is found by dividing the total general expense by the total number of hours charged to productive labor, which, in the report shown, amounts to twenty one and a half cents. This done, we are prepared to calculate the total cost of any order in the works. On short jobs, commenced and finished in the same month, all necessary figuring may be done on the form shown in

COST STATEMENT.

Shop No. *2468* For *Special 12-Spindle Drill.* Order No. *7829.*

WEEK ENDING	DRAWING ROOM.		PATTERNS. Amount.	CASTINGS. Amount.	STOCK. Amount.	MACHINE SHOP.	
	Hours.	Amount				Hours.	Amount.
Dec. 4	*40¾*	*12.36*					
" *11*	*8½*	*2 41*	*112.50*	*3 68*	*20.16*		
" *18*				*53.84*	*1.88*		
" *25*	*1*	*.42*		*13.70*	*125.00*	*22¾*	*3.75*
" *31*				*27.18*		*34*	*6.80*
TOTAL	*50¼*	*15 19*	*112.50*	*98.40*	*147.04*	*56¾*	*10.55*

Drawing-Room Time,	*50¼*	General Expense,	*22.79*
Machine-Shop Time,	*56¾*	Drawings,	*15.19*
Total Time,	*106*	Patterns,	*112.50*
Hourly Burden,	*.21½*	Castings,	*98.40*
	159	Stock,	*147.04*
	212	Labor,	*10.55*
General Expense,	*22.79*	Cost,	*406.47*

REMARKS: *The contract price for the above is $500.00. Profit=$93.53.*

FIG. 9. ILLUSTRATING THE USE OF THE HOURLY BURDEN.

Fig. 9, which will serve to illustrate the way in which the hourly burden is used. The interest on new assets (item S) is calculated from the assets for each month, and is taken at six per cent. for the remaining months of the year, which makes it unnecessary to change the interest and deterioration item (R) more than once a year.

The value of these reports in making an inventory will be obvious to every one. They make easy what, to most managers, is a troublesome problem. This, however, is a subject by itself, and, like other features of the system, is left for discussion in a future paper.

The advisability of making an individual tool charge is a question that every management must decide for itself. Personally, I think there is little in it, except for shops using both very heavy and very light machinery. The difficulties connected with acquiring any degree of accuracy by this method are stupendous, and the results, when obtained, afford but small compensation for the additional cost involved in the bookkeeping. Only substantially-accurate results are possible by any method of cost-keeping, as there is sure to be a more or less unfair distribution of the general expense account, the unfairness varying in accordance with the difference in value of the machines. If a firm's product consists of but one article, such as bicycle balls, the whole plant can be regarded as a single machine, without in the least affecting the accuracy of an even distribution of the general expense account; but, where a manufacturer builds a variety of lines, it is necessary to determine the hourly burden of each department separately.

THE BUILDINGS OF OXFORD, FROM AN ENGINEER'S POINT OF VIEW.

By J. W. Parry.

THOUGH there are many works on Oxford treating the beautiful buildings in the city historically, archæologically, and architecturally, as also several illustrated guides for visitors, yet the special information which an engineer requires has not been obtainable without much research and observation, consultation of well-known authorities, and deduction of conclusions. These "notes" make no attempt to fully describe any structure, nor are they intended to be "a guide" to the ordinary visitor; they refer chiefly to special characteristics, worthy of notice by an engineer or architect.*

A practical engineer arriving at a city built of stone situated on the "Oxford clay" would naturally enquire for the quarries. He would then find that the stone used in the various structures may be divided into two groups,—primitive Oxford, and modern times. Primitive Oxford, before the thirteenth century, consists of Chilswell, a rag, Wheately, a white laminated limestone, and Gibraltar, a blue magnesian limestone.

Modern times consists of Milton and Taynton, but chiefly Headington, or Heddington, from the quarries of that name two miles northeast of Oxford. This stone is divided into two strata,—an upper bed of soft oolite, which decays rapidly, and a bottom bed of compact magnesian limestone, which has been much used in New College, and, wherever adopted, has been found to last much longer than the material from the upper layer. Burford, or Bampton, is a variety of Taynton; Hincksey is a mountain limestone, like Gibraltar. In the restoration of St. Mary's spire the architect, Mr. T. Graham Jackson, has used Chipsham, from Rutlandshire. As most of the stone used in the buildings is limestone, there has been no difficulty in procuring good building lime; latterly, however, a more hydraulic lime has been ordered from Rugby.

Up to the time of the Tudors timber is mentioned in various college records as having been brought from Cumnor, Eynsham, Stowewood, Horsham, Beckley, and Shotover—a hill near Oxford. Most of this timber was conveyed to High Bridge during the floods, being cut in the autumn and used in the following spring. The varieties mentioned in the records are oak, elm, chestnut, ash, and beech. Some of the original timber, more than three centuries old, still exists in New College. From the time of the Stuarts logs of foreign timber were floated up the Thames to Burcot, where the remains of old landing stages still exist, and were thence carted to their destination.

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* The writer begs to return his thanks to Mr. H. Hurst, of the Taylorian Institution, for his invaluable assistance, his knowledge of old Oxford being as unrivalled as his enthusiasm is boundless.

The roofing material formerly used has a whitish, or bluff, look,—a schist, called in trade language Lincoln sheer slate, though it came from Stonesfield, near Woodstock. The Bangor, or Westmoreland, slates began to arrive after the canal boats were in full operation, about 1830, and have now entirely superseded the old Stonesfield schist. In 1190 a fire occurred, doing much damage to the numerous reed covered buildings; so stone and slate came into common use, instead of timber and thatch.

Each college is built round a quadrangle with a large entrance gateway which often rises into a quasi-tower. The rooms immediately over the gateway are invariably designed for the residence of the warden, provost, or principal of the college, so that the eye of the master may be over all who enter or leave the place. This mode of building still exists in India, being introduced into Europe by the Moors when they conquered Spain, where we find that the compound, or quad, is still used for the tethering of all kinds of animals.

Most of the colleges have been constructed on the sites of previous "Aularia," or halls, which were simply lodging-houses for students, and were pulled down to make room for the proposed college. Thus ten halls made way for New College, eight for Brasenose, five for Corpus Christi, and so on. Around the quad are arranged the chapel, library, hall or refectory, president's lodgings, buttery, and kitchen: the students' rooms generally occupy the upper floors. William of Wickham, the celebrated architect, wisely placed his taller buildings, the chapel and hall, on the north side, to keep off the cold winds, the lower buildings on the south more freely admitting sunshine.

In all cases the colleges were due to the generosity of private benefactors, the donor's wish being ratified by royal charters because opposed to the statute of mortmain. These benefactions generally took the form of rents in money, land, or both. The colleges can hold real and personal property. It is a popular delusion that the university is largely endowed by government. The royal endowments—seven in number—paid by the exchequer do not exceed £300 per annum. On account of the serious fall in land values during the last twenty-five years, the incomes of the colleges have been much diminished; still each college employs a surveyor to look after its estates, which are situated in different counties. Until recently the college authorities had unlimited powers over the funds at their disposal. Unfortunately, these powers were not always utilised to maintain the colleges in the highest state of sanitary efficiency, according to the model by-laws. As a result, these powers were curtailed considerably by Mr. Gladstone, each college being compelled to refer sanitary matters to the local government board for orders.

As constant reference will be made to groined vaulting and hammer-beam roofs, it is necessary to remind the reader of these two structural features. The following divisions of vaulting are suggested: (1) Norman,—*i. e.*, cylindrical, either plain or crossing, with or without ribs, as in the triforium of Christ Church; (2) early English,—*i. e.*, pointed vaulting, which invariably has cross-ribs and generally diagonal ribs also, as in the choir of SS. Philip and James and the chancel of S. Peter-in-the-East; (3) pyramidal,—*i. e.*, the ribs meeting in geometrical figures; (4) late decorated, or perpendicular, in which pendants are frequently introduced, as in Christ Church choir, said to have the finest vaulting in the world, and the divinity schools, with figures in the niches. Buttresses and vaulting are intimately connected by statical laws, yet it is worthy of notice that Oxford had not a single case of a flying buttress till 1896, when the church of S. John the Evangelist at Cowley was built. This characteristic of Gothic architecture was very common in early English and perpendicular periods in many parts of England.

GENERAL VIEW OF HIGH STREET. FROM AN OLD ENGRAVING.

THE CHAPEL OF ALL SOULS, SHOWING WREN'S SUNDIAL.

It is strange that Brandon, when dealing with the open timber roofs of the middle ages, confines his remarks chiefly to those met in Norfolk and Suffolk, omitting to mention so good an example as the chapel of All Souls. The beamless roof is in keeping with Gothic architecture, lends itself to decoration or enrichment, and can be boarded under the timbers, being thus divided into panels, or "Cants," by moulded ribs, to which can be attached carved bosses at the intersections. There are three kinds of hammer-beam roofs: (*a*) those in which the walls are incapable of carrying more than the weight of the roof; (*b*) those in which the walls are firmly buttressed, unyielding, and capable of withstanding the full thrust of the roof; (*c*) those in which the wall carries a portion of the thrust—say, one-fourth. If stress diagrams are drawn for the same span under each of these modes of loading, they will be found to vary enormously; the timbers are subject to more stress in (*b*) than in (*a*), and more in (*a*) than in (*c*), and so require larger scantlings.

A peculiar device, introduced, possibly from Italy, by Messrs. Street and Drinkwater, into the churches of SS. Philip and James and S. Margaret, may be mentioned. Hooks attached to a gun-metal framework upon the impost of arches which have to bear much strain were braced together by iron bands, which were taken away when the building had settled into position.

Oxford is celebrated as a place where church bells are frequently ringing. To the engineer and architect bell-ringing introduces a novel problem in construction and mechanics. The early towers were built some centuries before the lightest bells were cast or forged, and so were never designed for bells. Later arose the problem of setting up a framework from which to hang the bells. To introduce one end of the beam into the wall was easy enough ; to get in the other end the old builders adopted a ready and careless mode, making a curvilinear slit down the face of the opposite wall, the longitudinal timbers merely resting on the cross baulks, instead of being firmly braced to them. The result was soon apparent in cracks along the tower. A bell weighing only 500 pounds produces, at a distance of 4 feet, 2,240 foot-pounds' leverage, which is sufficient to crack the walls, especially when made of haphazard mortar. But there was another cause of vibration. The bells were hung from an upper framing supported on the main, or cross, beams ; this should have been kept free of the walls, but, instead, wooden wedges were often inserted at one or both ends, thus introducing a hammering action at another and probably weaker part of the wall. Thus the wall was subject to the action of two forces,—a leverage at the support, and a hammering action at the level of suspension. To these causes must be attributed the cracks in all towers. In Vol. II of Violet-le-Duc's architecture, sketches will be found showing the bell framing, but the author does not discuss the mechanics of the question. There is another point of great interest. If all the bells swing in one direction, then only two walls of the tower have to bear the oscillation. The designer of Merton Chapel, a well known early example, avoided this by so suspending the bells that they rang to the four points of the compass, the ringing being done from a square gallery below the bell floor. It is only within recent times that the hammering action of bells on walls has been understood, and resisted by putting tie rods, one or two inches in diameter, through the walls, heating them, and then bolting the ends, thus drawing the walls together, or, rather, preventing them from bulging.

Assume that a person walks down "The High" to Magdalen Bridge from Carfax, turning round King street and passing through the two quads of Christ Church, he arrives at "Old Tom." Suppose he then continues up S. Aldate's and Turl street into S. Giles's, afterwards retracing his steps along Broad street and Holywell. By this route he passes the colleges and churches in the following order :

I. DOWN THE HIGH. (1) All Saints Church. (2) Brasenose College. (3) Church of S. Mary the Virgin. (4) All Souls College. (5) University College. (6) Queens College. (7) Magdalen College.

II. KING STREET. (1) Merton College. (2) Corpus Christi College. (3) Oriel College.

III. S. ALDATE'S. (1) Christ Church. (2) Pembroke College. (3) S. Martin's Church, Carfax.

IV. TURL STREET. (1) Lincoln College. (2) Exeter College. (3) Jesus College.

V. S. GILES'S STREET. (1) S. John's College. (2) S. Mary Magdalen. (3) S. Michael's Church.

VI. BROAD STREET. (1) Balliol College. (2) Trinity College. (3) The old schools.

VII. HOLYWELL STREET. (1) Wadham College. (2) Hertford College. (3) New College. (4) Church of S. Peter in the East.

VIII. MISCELLANEOUS. (1) Worcester College. (2) Sheldonian theatre. (3) Radcliffe library.

There are other colleges and churches of minor importance.

All Saints Church.—This is a handsome barn with Corinthian pilasters, measuring 70 feet by 44 feet inside. It has the distinction of being the church where the right worshipful the mayor and aldermen of Oxford carry on their devotions. The "bidding prayer" on behalf of these gentry is quaint, but need not be repeated here. The tower is only 11 feet square inside, the walls being 5 feet 5 inches thick, of random rubble, and even 3 feet 9 inches thick at the belfry. Yet the mediæval spire fell in 1699; so it must have been badly designed, or else the masonry must have been so poor that the ringing of the bells cracked it. A wooden roof of 44 feet span is unusual, and, as no information could be obtained about the details of the roof, the writer determined to measure the timbers. There are nine Queen post trusses, the end ones being 10 feet 6 inches and 12 feet 6 inches, respectively, from the walls, while the others are alternately 7 feet 2 inches and 7 feet 11 inches apart. The tie beams are of solid oak scarfed and clamped, the width varying from 10½ to 12 inches and the depth from 15 to 18 inches. A few beams only are 18 inches deep, the greater number being 16 inches. There is no straining sill, and the distance, centre to centre, of straining beam and tie beam is 11 feet 9 inches. The rafters, struts, and posts consist of solid timbers. For the roof, dated 1706, Queen Anne supplied the oak. The beams carry a heavy stucco ceiling. In the *Building World* the writer asked the following questions, but has not received any replies.

(1) What weight does each beam carry, and how much could it carry? Is the latter as much as seventeen tons?

(2) Can other instances be given of wooden tie beams spanning 44 feet? If so, where?

ALL SAINTS CHURCH.

(3) In some college record it is vaguely stated that chestnut timber was supplied for the roof. Could this timber be employed for beams? If so, for what spans? Or is its use restricted to small scantlings?

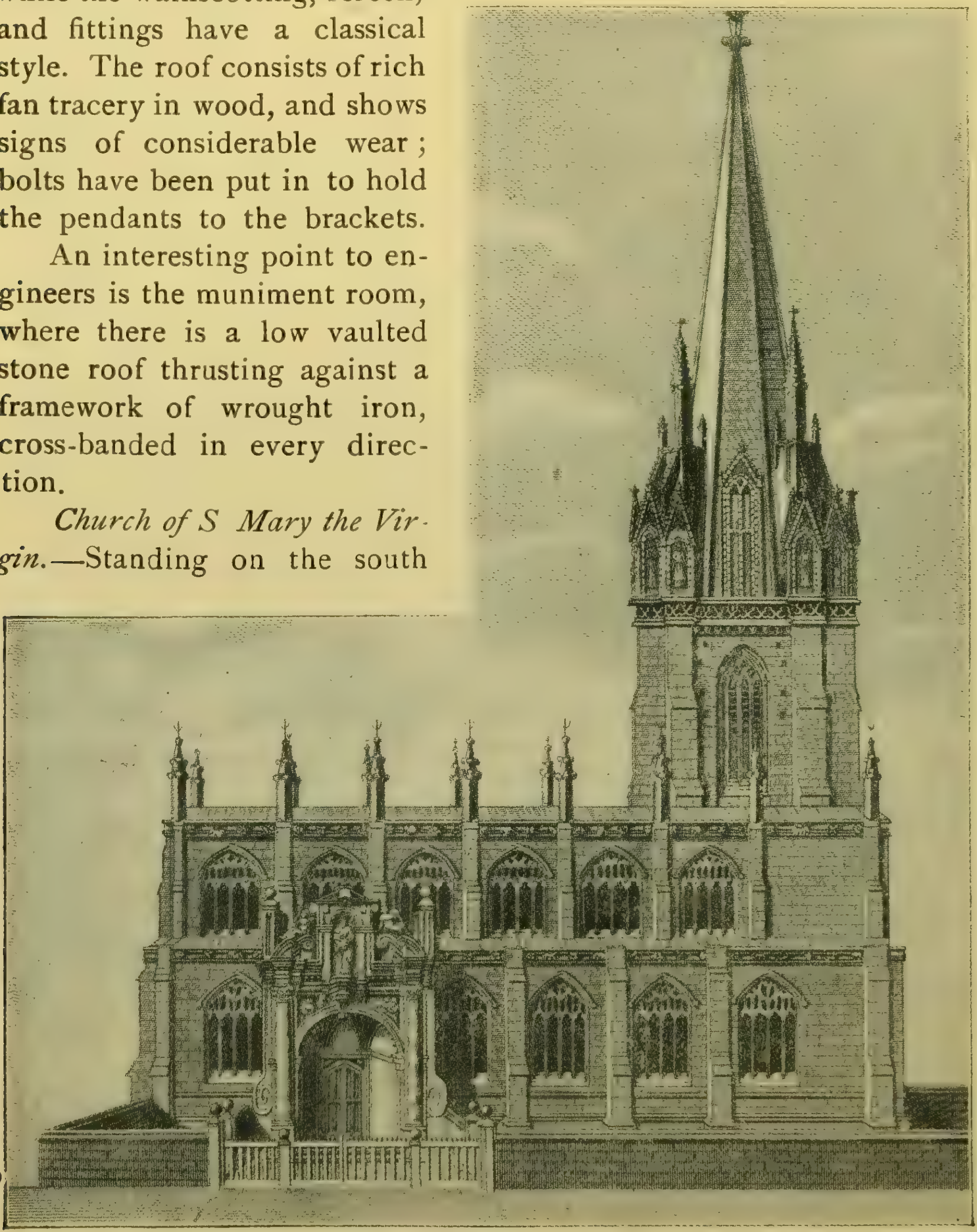
Nearly half the roofs in college buildings are thought to be of chestnut (the edible variety), this timber having much of the "figuring" of oak, - a good deal of rigidity combined with lightness.

Brasenose College.—The present extension of the college premises, with the gateway into the High, was not finished till 1890. The original and usual entrance is opposite the Radcliffe library. Eight halls were merged in this college, which was founded in 1509. The old gateway is handsome, but the entrance to High street might have been made more imposing.

The chapel is interesting as being one of the few structures built during the Commonwealth. The roof and windows are Gothic, while the wainscotting, screen, and fittings have a classical style. The roof consists of rich fan tracery in wood, and shows signs of considerable wear; bolts have been put in to hold the pendants to the brackets.

An interesting point to engineers is the muniment room, where there is a low vaulted stone roof thrusting against a framework of wrought iron, cross-banded in every direction.

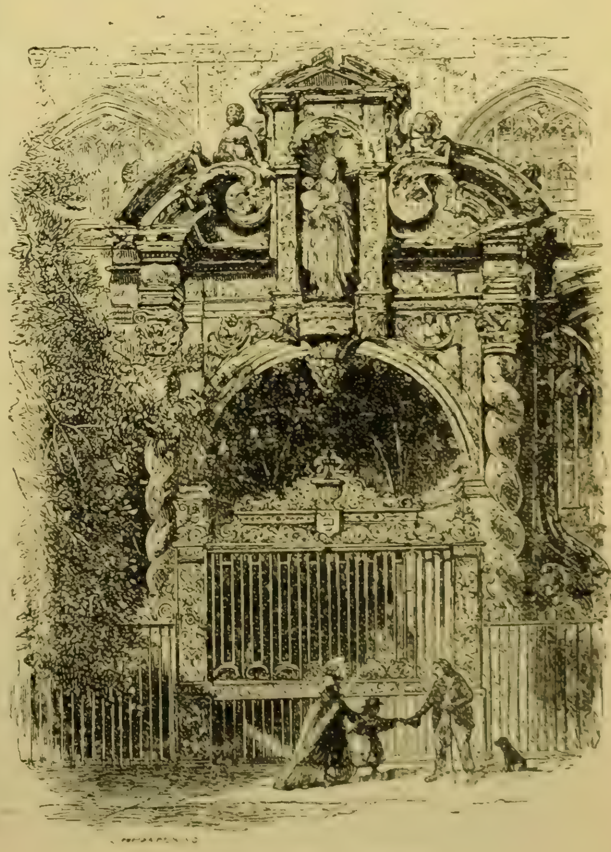
Church of S Mary the Virgin.—Standing on the south



SOUTH VIEW OF S. MARY'S, OR UNIVERSITY, CHURCH.
Where is the Chancel 68 ft. long?

side of the High, one notices the beauty of "S. Mary's Clusters," as they have been happily called. The decorated pinnacles of the tower, with canopied niches full of statuary, are justly admired. Each angle of the tower is flanked by a double buttress consisting of six stages, which gradually diminish as they rise, being united above by an open parapet of trefoil work which surrounds the base of the spire. The top of the spire is 189 feet above the ground,—the same height as that of the spire of Salisbury Cathedral. The stability of the tower and spire has given rise to an interesting question in mechanics between Prof. Case of Merton and the architect, Mr. Graham Jackson, which will be dealt with further on. Meanwhile the trained eye of an engineer or professional man will at once detect that the parapet over the roof of nave and chancel is not of similar design, nor does it run in a horizontal course, there being a drop of 18 inches at one point. The difference in style, in windows, buttresses, parapets, and cornices, is very striking. The porch, with its twisted columns, arrests the attention of the most casual observer. The only similar columns the writer has ever seen are those at the grand altar in S. Peter's at Rome, which are solid malachite, polished, and were presented to the pope by one of the czars of Russia. The idea of spiral ornamentation was not new, being supposed to have an eastern origin, but the moulding of an entire shaft into a spiral was one of the multitudinous whims of the seventeenth century.

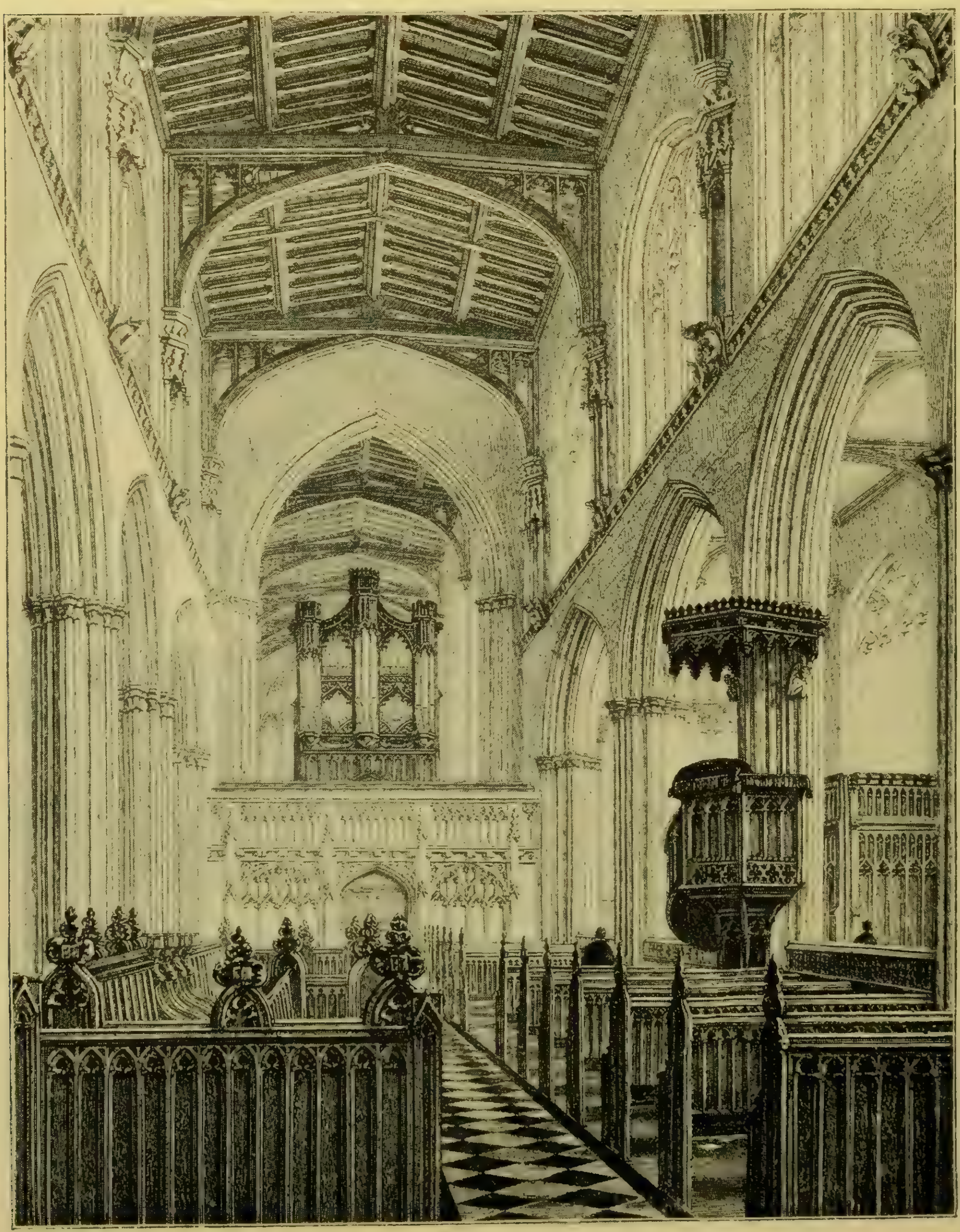
The nave of S. Mary's is 94 feet by 54 feet, including the aisles, and 70 feet high. The chancel is 68 feet by 24 feet. Distinct chapels and chantries formed S. Mary's, all of which are obliterated. The old congregation house was the chancel of an old church up to 1200, and still exists, at a lower level than that of the present chancel and nave. This congregation



GATEWAY OF S. MARY'S.

house was for the use of all the scholars of the University, and here was kept the University chest, with five keys, to hold the pledges for money borrowed from *alma mater*.

Now to the interesting dispute between Prof. Case, of Corpus Christi College, and Mr. Jackson, about the stability of the spire. Mr. Jackson's reports can be found scattered in the *University Gazettes* from 1889 to 1896. Prof. Case has published a small book, while Mr. Jackson has also written a handsome volume on S. Mary's



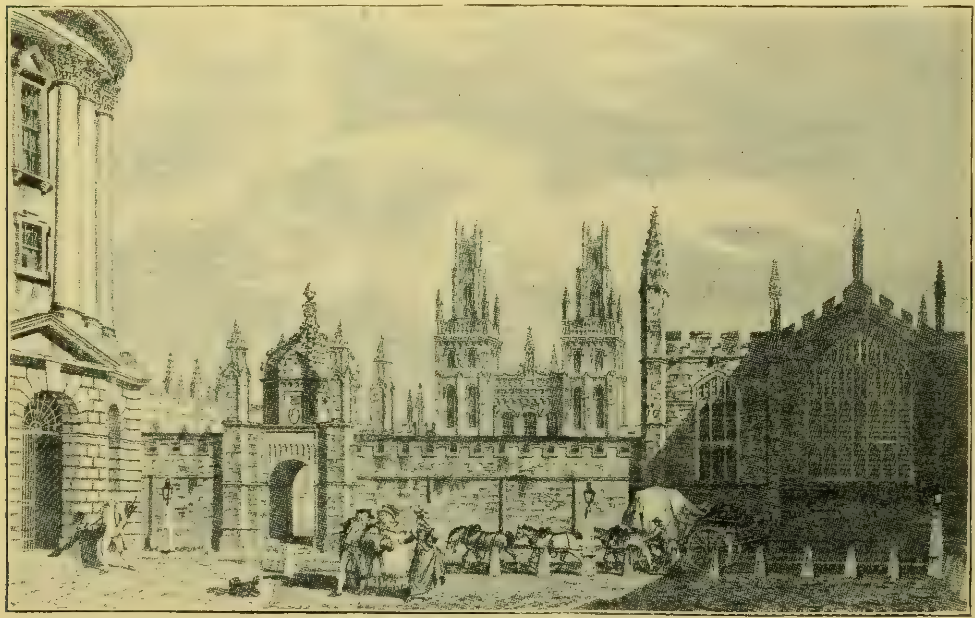
INTERIOR OF THE CHURCH OF S. MARY THE VIRGIN.

FRONT OF UNIVERSITY COLLEGE.

Clusters, totally ignoring, however, the vexed question. It appears that in March, 1889, some crockets and finials began to fall down, and Mr. Jackson was called upon to make a report. On erecting a scaffold, he found that most of the stone of the steeple and the pediments of the gablets had been formed of raking beds, and were in danger of slipping off, and also that a large mass of masonry might go through the roof of the nave. In addition, he found that the parapets and pinnacles of the nave and some of the north aisle, though re-erected in 1862, were completely decayed or in danger of falling. His estimate for repairs was as follows:

Southwest pinnacle	£1892
The other three pinnacles and sides	5555
Pierced parapet, round top of tower, and springing of spire	215
Tie rods and repairs	227
	£7889
Scaffolding and making good	800
Clearing up, etc.	44
	£8733
Nave parapets and pinnacles	1207
Other items	1693
Total	£11,633

From various causes the cost has steadily increased, till more than twice the amount originally intended has been paid for restoration. The writer has had the privilege of talking with Prof. Case, and believes that his views may be correctly represented as follows. The Hebdominal Council, not being satisfied with the explanation given by Mr. Jackson, under the guidance of Prof. Case drew up a set of questions for the architect to answer. These questions are too numerous to detail here, but they may be epitomised thus:



THE WESTERN SIDE OF ALL SOULS COLLEGE.

A. Questions calling for dimensions of tower and deflection of spire ; also the state of the four piers on which the tower rests.

B. Questions about pinnacles.—Does the mass of masonry 5¾ feet by 6¾ feet by 28 feet rest on tower or press on spire? What weight is required to resist the thrust of the spire? Does not this mass of masonry weaken the tower, especially at the northwest corner, where the tower once sank?

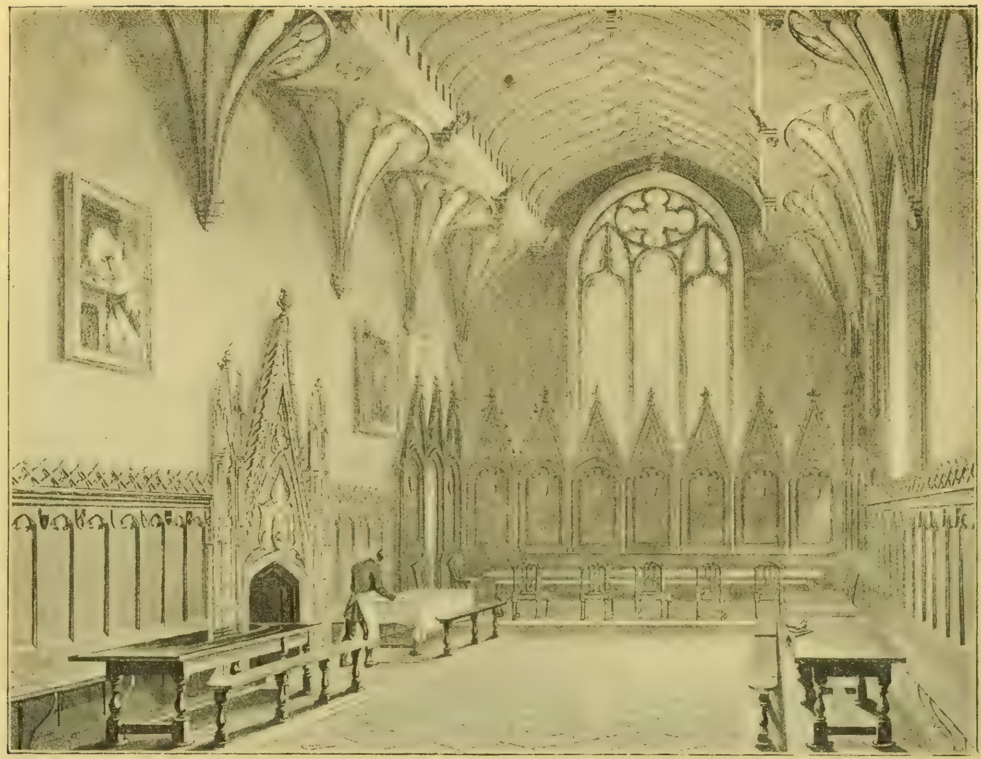
Mr. Jackson gave his replies to these questions, the most important answer being that there was no lateral thrust of the spire, as it was built in horizontal courses. The Hebdominal Council, still unsatisfied, called in as an expert Mr. (now Sir) Wolfe Barry, late president of the Institution of Civil Engineers. He caused bells to be rung from the tower, and found no distortion. He also agreed with the architect that there was no lateral thrust of the spire. It is apparent that the architect has put two bands of copper round the spire, and the cornice shown in Loggan and Turner's drawings has not been reproduced by Mr. Jackson. As far as one could gather, Prof. Case would have liked the architect to pull down the whole of the tower as well as the spire, as he considers that the former is in a state of unstable equilibrium and that the tower, with spire, may collapse at any time.

All Souls College.—The account-books of this college are in an excellent state of preservation, from which we are enabled to get a correct idea of the wages paid about A. D. 1438. Carpenters and sawyers got 6d. a day; daubers, 5d.; stone diggers and labourers, 4½d.; masons and joiners, 8d.; a master carpenter, 3s. 4d. a week, enjoying also a tithe from each labourer employed under him,—a custom still existing in many parts of India, and which the engineers there are trying to abolish. A skilled image-carver received 4s. 8d. a week, with bed and board, as he generally came from a distance. In those halcyon days a horse cost the modest sum of £3.

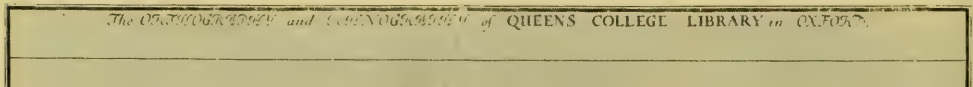
Attention is called in some books "to the exquisite vaulting of fan tracery work" in the narrow entrance to the chapel, where there is a stoup for holy water. The writer considers the tracery ordinary; there could have been no constructive difficulty, as the passage is only a yard wide. The reredos, with its delicate carving, is much admired; it is copied from that in New College. The crypt under the chancel is not mentioned in any of the usual guide-books, and few people have even heard of it.

In the northern quad are the twin towers, which distinguish All

THE LIBRARY OF ALL SOULS. BY ACKERMAN, 1814.



HALL OF UNIVERSITY COLLEGE.

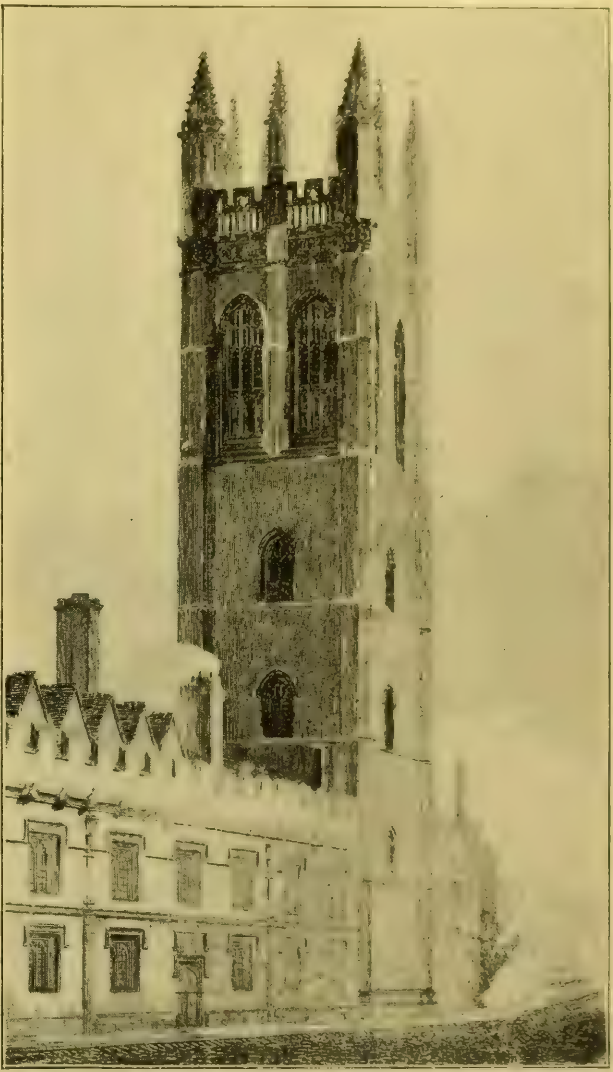

The ORTHOGRAPHY and ICHNOGRAPHY of QUEENS COLLEGE LIBRARY in OXFORD.

PLAN AND ELEVATION, QUEEN'S COLLEGE LIBRARY.

Souls from any other similar institution, and Hawksmoor's diminishing turrets, with a modern arcade. The present library, shown in the engraving on page 409, is a fine room 200 feet in length by 30 feet in width, and 40 feet high.

University College.—This has one of the longest façades in Oxford, there being two gateways with two quads, each gateway having a richly-groined vault of similar design. The ground plan of the eastern gateway is very much out of the square,—clearly so intended, though the motive is not easily guessed. Probably this is due to the bend of the High street, which occurs just here.

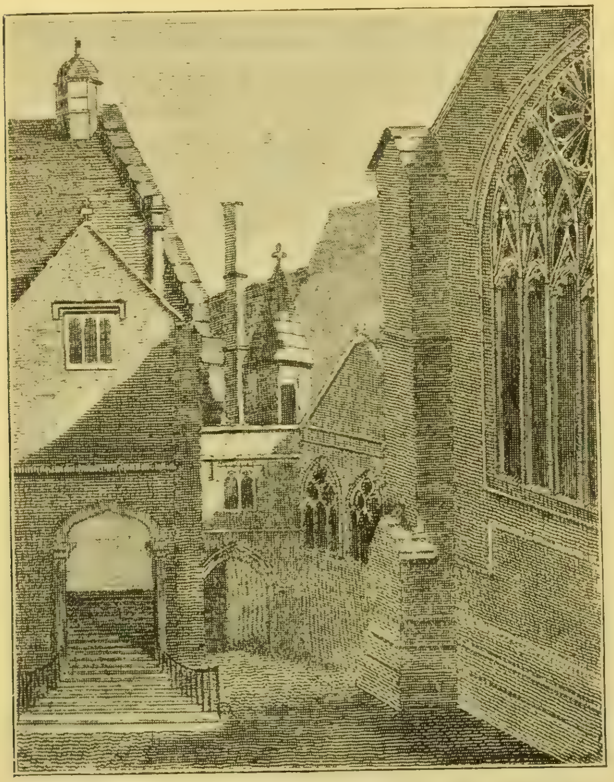
The wainscotting round the chapel altar is of cedar; the rest, of foreign oak. There is some delicate carving in the screen, and a curious copy of Salvator Mundi, burned in wood by Dr. Griffiths. The monuments are of chaste design, especially that of Sir William Jones, the chief justice of Bengal, by Flaxman. The college is chiefly visited for the Shelley Memorial, which is placed in a glazed alcove.



TOWER OF MAGDALEN COLLEGE.

Queen's College.—This building can at once be recognised by the cupola over the gateway, within which is a statue of Queen Caroline, consort of George III.

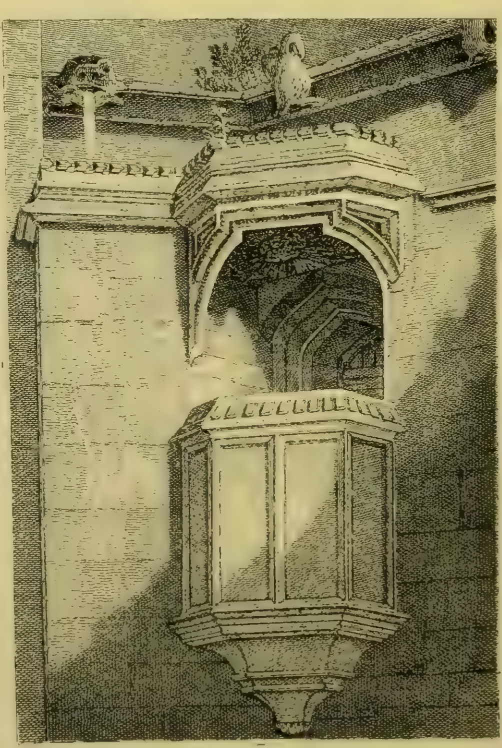
The hall and chapel of the college are opposite the entrance to the quad, the former on the left and the latter on the right. The chapel is chiefly remarkable for being Doric without and Corinthian



ENTRANCE TO MAGDALEN COLLEGE.

within. The hall is plain, but lofty. The queen's concert takes place in this hall yearly.

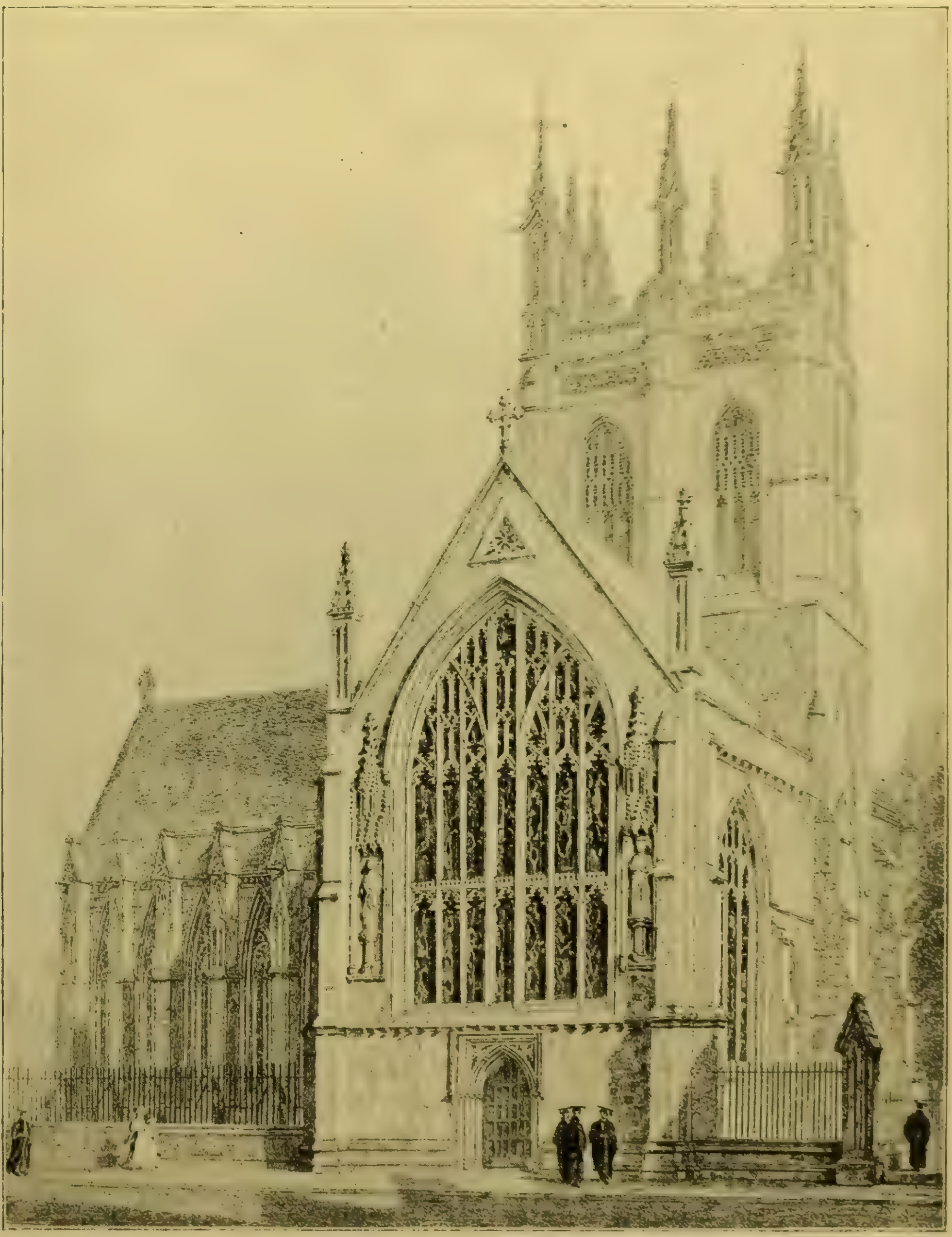
Magdalen College.—This college is well known all the world over, and the writer is particularly interested in it, as it was built on the site of a hospital on a small island formed by the Cherwell, called Parry's or Paris' isle. Contract documents for many of its parts exist, signed by a master mason 1475–1479—for instance, specification "for the spire of stone to be in altitude from the corbel table sixteen feet; pinnacles of stone over the hall and church, with the embattlements of those buildings and the library."



ANCIENT PULPIT, MAGDALEN COLLEGE.

On entering through the porter's lodge every one notices, at the northwest angle of an ancient oratory, the curious pulpit of stone erected by Waynflete for open-air service. Certain Parisian abbeys are said to have similar out-door pulpits. We also have records of two others at Oxford; unfortunately both have disappeared.

Of the chapel the records say that "few edifices in Oxford probably have experienced so many vicissitudes, and yet have retained so much of the original character." The Puritans smashed the glass and statuary, and took away the organ to Hampton Court. The present roof of the chapel is stucco, but the earlier one which it replaces had open trusses of timber carved and moulded inside, like that of All Souls Chapel. The west window, in *chiaroscuro*, has a handsome effect; the chapel, hall, and part of the cloisters formed the original design.



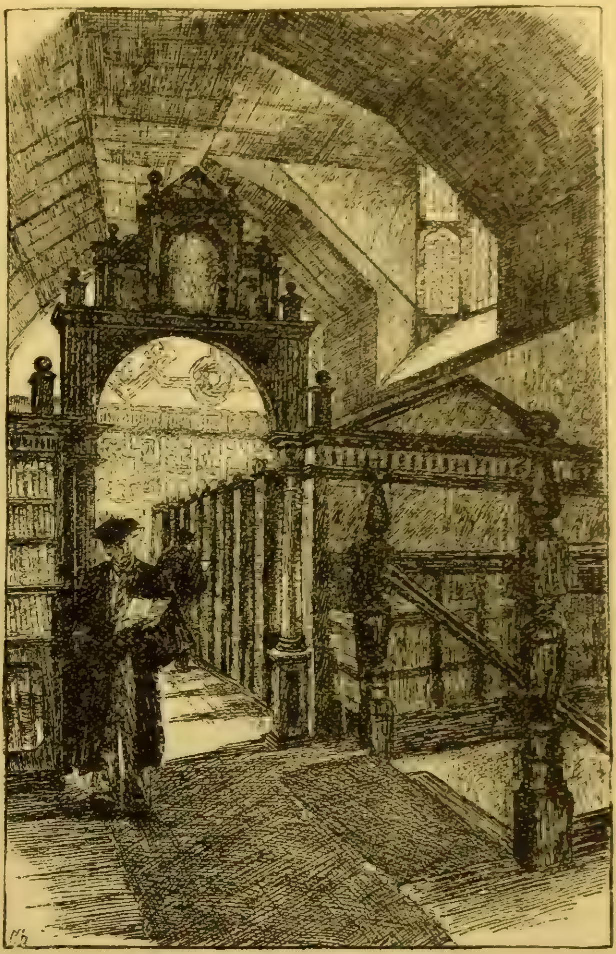
MERTON COLLEGE CHAPEL.
From the South West.

On the north side, beyond the cloisters, there is a large block of buildings which might have been intended for barracks or a prison, as the architect has put no elegance into his design. The view of Magdalen Bridge and tower and up The High from the Iffley road has always been justly admired, but it is a pity that the tower, which is 145 feet in height, is built on so low ground that it loses much of its impressiveness.

Merton College.—Ingram states that seventeen or eighteen halls were merged to form this college, whereas the documents refer to only ten or eleven and a water mill. In some of the halls lectures were given, while in others trades were carried on. The founder obtained three charters, one of which is of interest, as it shows an intention to bring the water of the Cherwell through S. John's Hospital (now Magdalen College). But how would the surveyor have crossed the deep city ditch? Would he have done so by a syphon? and did they know how to take levels in those days?

ORIEL COLLEGE. FROM AN OLD ENGRAVING.
The figures on the left represent Edward II and Adam de Brun.

Opposite the entrance is a flight of steps leading to the hall. The doorway, with its hammered iron work, is a grand example of genuine forging of fourteenth-century origin, worthy any smith's inspection. On passing the archway on the left it will be seen that the signs of the zodiac are cut on the bosses; beyond, in the quad, is a tower, ornamented with reliefs showing the four orders of architecture—Doric, Ionic, Corinthian, and Tuscan. Above the "Mob" quad is an octagonal turret enclosing a stone staircase leading to the treasury. The roof is ashlar (not slate), supported on three circular ribs. Externally the gables have the appearance of equilateral triangles. Here we have an early example of a fireproof building, as good as any that could be constructed in modern times.



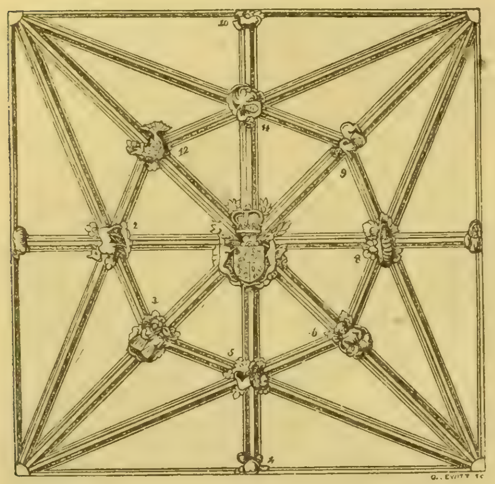
THE LIBRARY, MERTON COLLEGE.

The chapel consists of a choir (1277), transepts, and tower, the transept forming the ante-chapel. These ante-chapels are a marked feature of Oxford churches, there being neither nave or aisles. The base of the tower is 33 feet by 22 feet inside; above, the corners are corbelled out and a gallery erected, from which the eight bells are rung.

This is a most unusual device, as bells are generally rung from a floor. The position of the bells is so admirably arranged that the vibrations are in opposite directions, the result being, of course, the effective counterbalancing of any oscillation tending to bulge out the walls.

The sacristy is an excellent example of what can be done in restoring a ruined building, and much credit is due to Mr. Graham Jackson, the architect.

Corpus Christi College.—On entering, the eye is at once arrested by a cylindrical shaft, called Turner's monument, with nine sun-dials



SIGNS OF THE ZODIAC, FROM ARCHWAY IN MERTON COLLEGE.

and perpetual calendar—the only one of its kind in Oxford. It is necessary to ascend some steps to reach the library, which is part of the nave of the chapel, being separated by a gallery pew. The timber roof of the hall is of massive black oak, being an excellent specimen of sixteenth-century work.

Oriel College.—The characteristic feature of this college is the half octagonal porch. The roof of the hall has a glazed louvre, or lantern, which is unusual for the halls of Oxford, though more common in those of Cambridge. These louvres were intended as an exit for the smoke in the days when there were no chimneys, a curb of stone being provided in the centre of the room to prevent the logs from rolling.

THE EXTENSION OF SUBMARINE TELEGRAPHY IN A QUARTER-CENTURY.

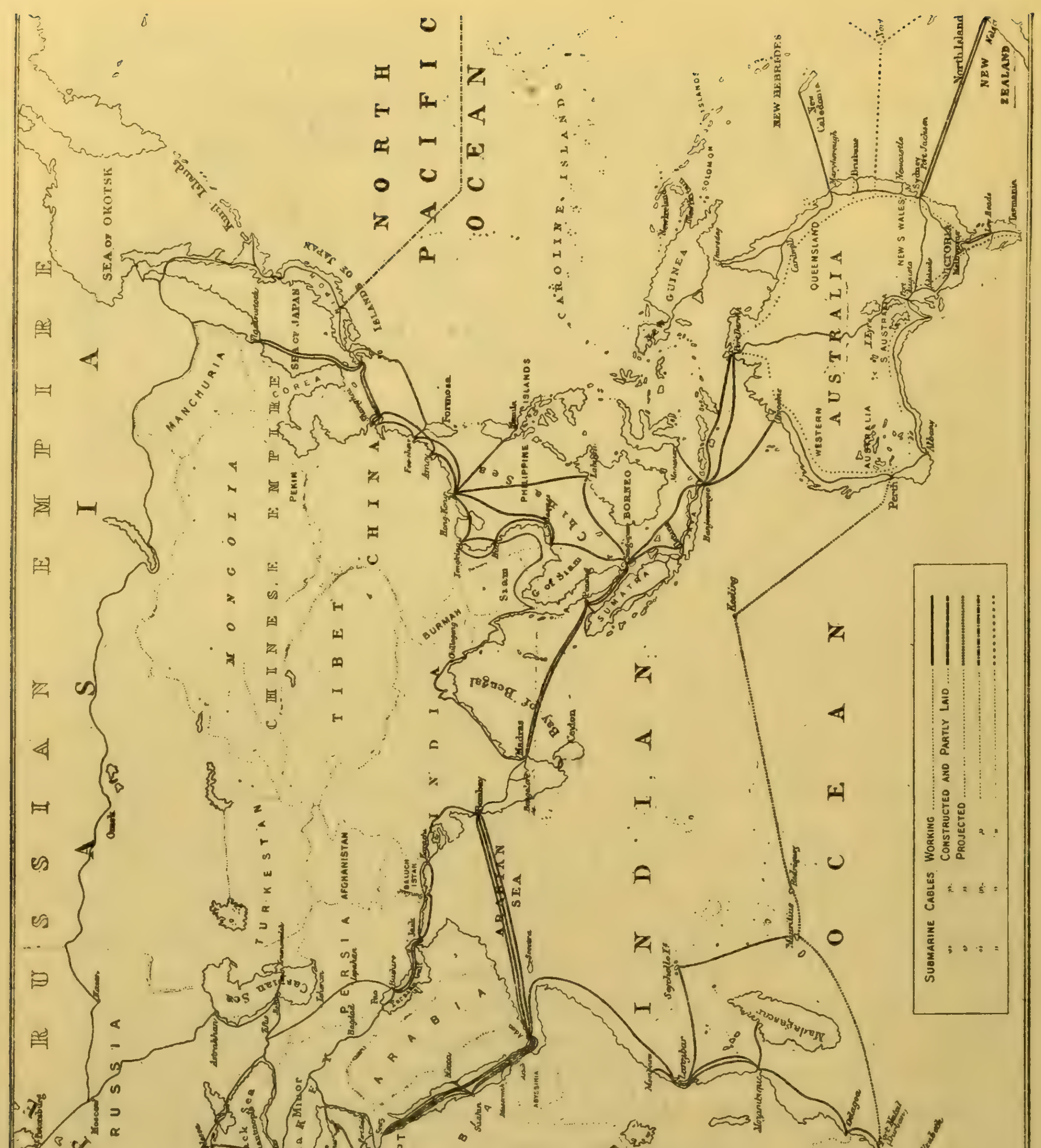
By Charles Bright.

THE last few decades have been characterised by a development and advance of engineering methods and achievements which, in the mechanic arts, is astounding, and, in almost the entire range of electrical engineering, is absolutely revolutionary.

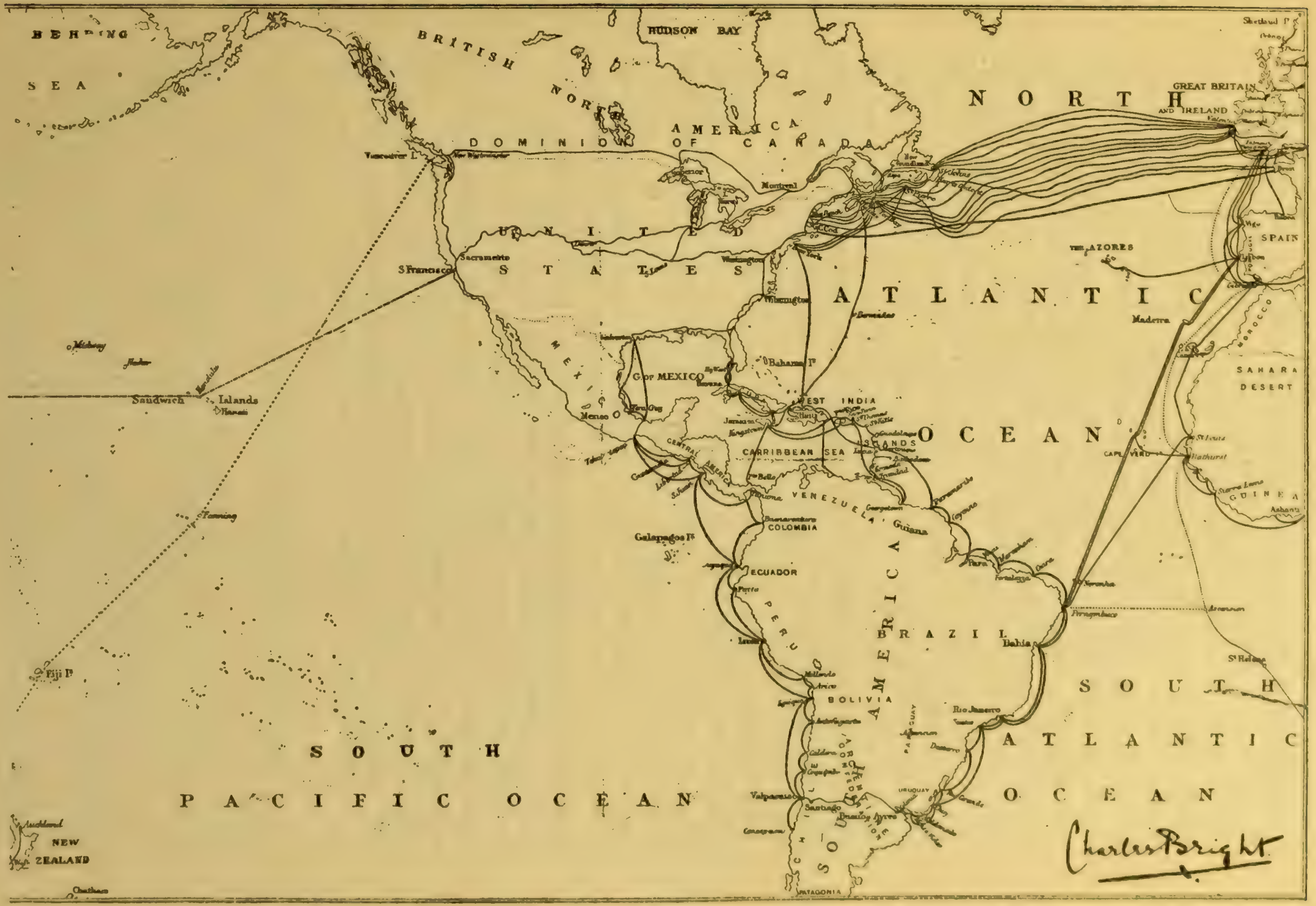
Unlike other applications of electricity, however, telegraphy, as now in vogue, was almost entirely worked out twenty-five years ago. Its laws had been laid down, and most of the pioneering done. The cable is the same; the instruments employed to work it are the same. Nevertheless, steady progress has been made, due partly to improvement in materials and their preparation, partly to improvement in details, partly to commercial enterprise and expansion.

Confining the review to telegraphy, as practiced in lines deposited in the depths of the sea, we may make the following summary of the condition as it existed twenty-five years ago. The Atlantic ocean had been spanned more than once. England was in telegraphic communication with the European continent through a number of cables to various points. The United Kingdom had established a double touch, telegraphically, with Egypt and India *viâ* the Mediterranean, Red sea, Persian gulf, and Arabian sea. Extensions reached to Australia, China, and Japan. The West Indian islands were linked with the American and European continents.

About this time, a number of amalgamations occurred in connection with some of the more important systems. All the work summarised had been accomplished during the peculiarly busy telegraphic period characterising the end of the seventh decade, and beginning of the eighth decade, of this century. It is to be remarked that scarcely any of the companies which ordered the construction and submersion of these lines, and which worked them (or are still working them) to the great benefit of the world's commerce, were assisted by any government monopolies, subsidies, or guarantees. It may truly be maintained, therefore, that the governments and mercantile communities of the world owe the vast benefits they have reaped from direct submarine telegraphic communication almost entirely to the enterprise of a few enthusiastic individuals and the original shareholders in these companies. Another point deserving incidental notice is that most of the later of these undertakings had been set afoot in England soon after the passing of the telegraph purchase bill. The promoters



CABLE CHART OF THE WORLD. THE EASTERN HEMISPHERE.



CABLE CHART OF THE WORLD. THE WESTERN HEMISPHERE.

Placed to the right of the chart on the page above, this makes a complete cable map of the world.]

rightly calculated that this afforded an opportunity of securing for new telegraphic ventures a good deal of the capital let loose by the winding-up of the Magnetic, Electric, United Kingdom, Reuter, and other telegraphic companies, which had, up to that time, shared among them the control of the land-lines of Great Britain and Ireland. This acquisition of land telegraphs by the State liberated something like £8,000,000 sterling for re-investment by those who looked favourably on electric telegraphs as a subject of safe and sure remuneration. Moreover, the publicity which the proceedings of the parliamentary commission, appointed in connection with the government purchase scheme, gave to the lucrative nature of telegraphic enterprises generally, together with the previous success of the Atlantic cable in deep water, emboldened financiers and capitalists to make fresh investments of the same character.* Twenty-five years ago some 51,000 nautical miles of cable had been laid. At present upwards of 167,000 nautical miles are resting at the bottom of the sea. This review is concerned with the 116,000 for which the intervening twenty-five years is responsible.

In January, 1873, a scheme was set afloat for establishing telegraphic communication between England and Brazil and the rest of the South American continent and West Indian islands in a more direct manner than by the existing route.

The following year this system and further extensions of it were carried out. The above cables were made and laid for the Brazilian Submarine, Western & Brazilian,† and other companies by the Telegraph Construction and Maintenance Company, by Messrs. Hooper, by Siemens Bros., and by Mr. W. T. Henley. While the bed of the south Atlantic was thus experiencing changes, a new line was also in contemplation for the north Atlantic. This, under the auspices of the Direct United States Cable Company, was the first competitor of the Anglo-American system. It was planned as a direct line, not to touch at Newfoundland; but it was found that, with the core determined on, the working speed would not be sufficient, and the cable was eventually taken ashore at Halifax, Nova Scotia. This was the first really big cable contract entirely carried out by the firm of Siemens, and it was executed with complete success.

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* Former shareholders in the Magnetic Company were especially predisposed to take a pecuniary interest in submarine telegraphy, in virtue of their connection with the early Atlantic lines.

† In 1895 the Western & Brazilian Company promoted an extension of its system up the Amazon river, and a company called the Amazon Telegraph Company was formed with this object. The cables for this new company were laid last year by Messrs. Siemens Brothers. The line extends from Pará to Manáos, nearly half-way up the great river, in the heart of Brazil and the plains of the Amazon. There are sixteen stations on the line altogether, its total length being more than 1,300 N.M. This cable is expected to further develop a large india-rubber, coffee, and sugar trade. All previous attempts at telegraphic communication by means of land-lines had proved unsuccessful, owing to the rapidity and density of forest growths in this part of the world. Indeed, in the case of the cable, the new experience of laying one up an immense river whose bed is subject to very considerable and frequent changes has in itself turned out a formidable business ever since the line was completed.

In the same year (1874) the India Rubber, Gutta Percha and Telegraph Works Company, of Silvertown, laid a cable for the Direct Spanish Telegraph Company between Marseilles and Barcelona, thus extending its system to France, and thereby constituting a kind of Anglo-Spanish connection with the Eastern systems, of which now, since 1885, it forms an offshoot. The telegraphic communication of Spain with the east, as well as with the rest of the European continent, was now doubly secured.

In 1876 the original West Coast of America Telegraph Company was incorporated. Its objects were to purchase and work cables on the coasts of Chili and Peru, as well as to put the latter into communication with the Western & Brazilian system, and then with Europe, by means of the land-line of the Transandine Telegraph Company and the River Plate and Platino-Brazilian cables. This West Coast of America Company's cables had been made by the Silvertown Company, and were laid by the same firm in seven sections during 1875 and 1876. The greater part was submerged previous to the actual formation of the West Coast Company—probably the only case of its kind. The company itself was originally constituted almost entirely of, and by, shareholders in the Silvertown Company; but subsequently, in 1877, it underwent reconstruction, and has become closely identified with the Eastern and its allied companies.*

A period of calm in the further extension of marine telegraphy now supervened, lasting until 1879. In that year the Eastern and South African Telegraphy Company was launched under the financial auspices of the Eastern group. Its purpose was to establish and maintain telegraphic communication between Aden (where it would connect with the Eastern company's system) and the Cape of Good Hope, by means of a series of cables down the east coast of Africa, joining, at Port Natal, a government land-line to Cape Town, which had been completed in 1878.† These cables were manufactured by the Telegraph Construction Company, and laid by them in 1879. Their combined length was as much as 3,900 N. M., one section alone—that from Aden to Zanzibar—measuring 1,915 N. M.

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* The West Coast of America Company's system has since been extended by the establishment of land-line communications with fresh points in the interior, the most important town so connected being Santiago, in 1889.

† The sea-bottom round the Cape is not at all favourable for a cable. Moreover, the land lines,—completed and harmonised in one system the previous year,—as worked by the Cape and Natal government telegraph departments, had proved thoroughly efficient and reliable.

The same (Eastern & South African) company has since placed one of the Seychelles Islands, as well as the important colony and naval station of Mauritius, in telegraphic communication with the rest of the world. This extension, joining its system at Zanzibar, was carried out for the company (by the Telegraph Construction and Maintenance Company again) in 1893. Another extension—down the lower part of the west coast of Africa to the Cape, being in other respects a continuation of the West African Company's system—will be referred to further on.

In 1879 another French company was formed to establish independent communication between France and the rest of the European continent on the one hand, and the United States on the other. The somewhat cumbersome title of this concern was La Compagnie Française du Télégraphe de Paris à New York ; but it soon became known as the P. Q. company, M. Pouyer–Quertier being the presiding genius. The cable was made and laid in the same year by Messrs. Siemens Brothers. This line afterwards joined the pool. In 1894, however, it was amalgamated with another company of French origin under the title of La Compagnie Française des Câbles Télégraphiques. Since this amalgamation it has withdrawn from the Joint-Purse.

In 1881 an American company was established, under the guidance of the late Mr. Jay Gould, entitled the American Telegraph and Cable Company, with a view to partaking in the profits of transatlantic telegraphy by establishing another line of communication between the United States and Great Britain, and thence to the east of Europe. This cable was also constructed and laid (in the course of that year) by Messrs. Siemens Brothers, who were part promoters of the enterprise, as well as another cable for the same system in the following year (1882). This company's cables work in connection with—are, in fact, leased by—the Western Union Telegraph Company, which was practically Jay Gould's property, and remained so almost to the close of his life. In 1883 the above system entered the pool—the happy destination for which, may be, it was originally launched.

In 1880 the Mexican Telegraph Company was formed by a body of American capitalists, and in the following year the Central & South American Telegraph Company was floated by similar hands. The object of these two schemes was to bring Mexico and the west coast of South and Central America into direct communication with the United States (*i. e.*, independent of the West Indian islands), thus also diverting through the United States part of the aforesaid traffic with Europe. The cables across the Gulf of Mexico were laid between 1880 and 1882, and those for the Central and South American Company along the west coast in 1882. The latter started from Peru, at the spot where the system of the West Coast of America Company ended, touching at Panama and various points of communication, and extending to the gulf of Tehuantepec. By means of a land-line across the isthmus of the same name, and a short cable on the other side, connection was made with the Mexican Company's cables at Vera Cruz. The Silvertown Company contracted for the manufacture and submersion of all these cables, those on the Pacific side comprising eight sections, with a total length of 3,200 N. M.

The Central and South American Company has within recent years (in 1891) extended its system to Valparaiso, and thence by land-line to Santiago, thus entering into competition with the West Coast of America Company. It purchased at the same time the Transandine Telegraph Company's land-line from Valparaiso and Santiago to Buenos Ayres (with its four intermediate stations), thus securing an independent connection of its own with the great Argentine and Uruguayan capitals, Buenos Ayres and Montevideo. By other land-lines through Brazil it also reaches Rio. This (Central and South American) company's connection with Europe is, however, exclusively by way of the Mexican Company's system, the Western Union land-lines, and the Atlantic cables to England and France.

In response to this move on the part of the American group, the West Coast of America, the Western & Brazilian, and the Brazilian Submarine Companies joined forces to promote another company in the following year for erecting a new land-line across the continent in their own interests. It is entitled the Pacific & European Telegraph Company. The construction of the required line followed soon after, along a route rather to the north of the Central and South American Company's, but connecting the same points with one intermediate station. This line was open for traffic in March, 1894.

In 1883 the Spanish National Telegraph Company came into existence. This company (with subsidies from the Spanish government) was founded to create and maintain telegraphic communication between Spain and her possessions, the Canary Islands, as well as to effect—by the help of another subsidy from the French government—an extension from the Canaries, thus connecting the European continent with the French colony of Senegal, west coast of Africa. The first part of the enterprise was carried out in the same year, and the second in 1884. The first part of this company's system, connecting Spain with the various Canary islands, was taken over in 1893, after ten years' working (according to the original agreement) by the Spanish government. The system in its entirety now forms a connecting link with continental Europe and England for the South American Cable Company's system which it joins at St. Louis, Senegal.

Two more African cable companies were registered in the latter part of 1885,—namely, the West African Telegraph Company, in September, and the African Direct Telegraph Company, in December. The former was promoted by the Silvertown Company, and was to work in connection with the Spanish National Company's system; the latter was an offspring of the Eastern group. These two companies had each obtained subsidies or guarantees from the various European governments—French, Portuguese, and British—to whom belong the different colonies at which it was proposed that the cables should touch, going along the west coast and including St. Jago and St. Vincent. The West African Company's cables were made and laid for them by the Silvertown people in the course of two expeditions, during 1885 and 1886. Starting from the southern terminus of the Spanish National at St. Louis, Senegal, this system extends to St. Paul de Loanda, serving eleven stations on the way, mostly situated in the Bight of Benin, where alone it can be said that cables behave better than men. The African Direct system was made and laid, about the same time, by the Telegraph Construction and Maintenance Company. Through the instrumentality of the two sections between the west coast of Africa (at Bathurst) and St. Jago and St. Vincent, this company secured its own communications with Europe *via* the Brazilian Submarine Company's lines to Lisbon, and thence by the Eastern Company's direct cable to England. Two years after this, the Eastern & South African Telegraph Company determined to extend its East Coast of Africa system by a cable from Cape Town, *via* Mossamedes and Benguela, to Loanda, the southern terminus of the West African Company's system. Going south, the first of the two sections—that between Loanda and Benguela—was made and laid by the Silvertown Company, and the other by the Telegraph Construction Company. Communication was thus completed, in 1889, along the whole west coast of Africa down to Cape Town. These three systems comprise nearly 8,000 miles of cable. It was now arranged that the West African Company and its cables should be taken over by the Eastern promoters, so as to constitute, with the African Direct and the Eastern and Southern African,—and for their mutual benefit,—one working system of alternative communications with the Cape. Each of the stations served by these three systems has an opportunity of transmitting, on the combined system, any messages it may have, at stated times during the day.

In the field of Atlantic telegraphy, a fresh competitor arrived in 1884,—the Commercial Cable Company. Two cables were laid across the Atlantic for this company in that year, its promoters foreseeing that, in view of the continual chance of a breakdown, only in this way could they safely attempt to compete with more firmly-established rivals. The Commercial Company was mainly promoted by two American millionaires, Mr. J. W. Mackay, the celebrated New York financier, and Mr. James Gordon Bennett, proprietor of the *New York Herald*, with whom were associated the Messrs. Siemens, who became afterwards the contractors for the enterprise. These cables, like the Jay Gould lines, stretch from the United States —one of them from New York—to Nova Scotia, and thence to the extreme southwest point of Ireland (which is connected by special cable with England). The system is directly connected with that of the Canadian Pacific Railroad Company, thus affording ready communication with the Dominion.

Neither the Commercial Company's system or that of the Compagnie Française des Câbles Télégraphiques is at present in the Atlantic pool; they, in fact, are the two exceptions referred to.

In 1886 the Italian government entered into a contract with Società Pirelli, of Milan, for the construction and maintenance of a number of cables—about 700 nautical miles in all—to connect various islands in the Adriatic and Mediterranean seas with the mainland, chiefly for military and naval purposes. For the execution of this contract the Società Pirelli built a cable-sheathing factory at Spezia, and a telegraph ship—the "Cittá di Milano"—in England, Messrs. Johnson & Phillips supplying the machinery for both. The core was made at the Milan works, and sheathed at those of Spezia.

Down to nine or ten years ago the French had not troubled themselves much about cables to their colonies or foreign parts, and the few they had felt necessary they got made and laid for them by English hands. Latterly, however, they have concluded to render themselves more independent of British lines of telegraphic communication, and with this object have commenced in earnest the work of making and laying cables on their own account. Thus in 1887 the French minister of posts and telegraphs signed a contract for the subvention of an extensive system of cables to connect the French colonies in the West Indies with French Guiana, communicating at Cuba with the United States and Atlantic systems, and at Viseu, ín Brazil, with the Brazilian land-lines to Rio and Buenos Ayres. A change of government led to the rejection of this contract by the chamber of deputies. Subsequently, however (between 1887 and 1888), a part of this scheme was carried out—as far as La Guayra, Venezuela. The cables were constructed by W. T. Henley's Telegraph Works Company,* which also contracted for the laying of them. Mr. R. E. Peake (of Messrs. Clark, Forde & Taylor) executed the latter part of the contract for Henley's, while Mr. W. S. Seaton acted as engineer on behalf of the proprietors, La Participation des Câbles des Antilles. In 1888 La Société Française des Télégraphes Sous-Marins was formed, to take over the above cables and extend them as soon as the chamber of deputies should ratify the contracts made with various ministers of posts and telegraphs. In 1889 the necessary ratification was obtained. Accordingly the society proceeded to enter into contracts with the Société Generale des Téléphones for the construction in France of the said extension cables. The cables were manufactured with complete success,—partly by the Société Française des Télégraphes Sous-Marins and partly by the Henley Company,—and were laid for the "Société Française" by Mr. W. S. Seaton between 1890 and 1891.

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* Half the required core, however, was made at the Bezons Works of La Société Générale des Téléphones. This was the first order that firm had obtained for submarine-cable core, and the result was exceedingly satisfactory.

The Halifax & Bermudas Cable Company was formed in 1889, to give effect to a contract with her majesty's government for laying a cable and maintaining telegraphic communication between the two important naval stations designated in its title. This contract has been, and is, carried out under a government subsidy of twenty-years' duration. The manufacture and submersion of this cable were given to Henley's Company, on whose behalf Captain A. W. Stiffe (formerly of the late Indian navy, and prominently connected with the first Persian gulf cables) was engineer in charge of the expedition. It passes through water as deep as 2,824 fathoms,—one of the greatest depths in which any cable is known to lie. The object of this telegraphic connection was imperial rather than commercial. It forms part of a scheme recommended by a royal commission in 1884 to provide a means of communication between the British West Indies and the mother country, passing entirely through British territory. As the line connects with several Anglo-Atlantic cables at Halifax, the direct communication demanded by the commission has been effectually established.

In 1891 the French government invited tenders for two cables to connect Marseilles with Oran and Tunis respectively. For the first time in the history of submarine telegraphy British contractors were excluded altogether. The Oran cable was allotted to La Société Generale des Téléphones, and the Tunis one to M. Grammont. The Oran cable (the core of which was turned out at Bezons, while the sheathing was applied at Calais) was laid by Mr. W. S. Seaton on behalf of the French contractors, under the inspection of M. E. Wünschendorff, the government engineer.

M. Grammont retained the services of a civil engineer and compatriot, M. Peltier, for laying the Tunis cable. He chartered the

Telegraph Construction Company's T. S. S. Calabria for this purpose, and availed himself of the assistance of some of the latter company's staff. For the manufacture of this cable, M. Grammont erected a factory (core and sheathing) at St. Topez, near Toulon.

In 1891 the South American Cable Company was promoted by those interested in the Silvertown business (India-rubber, Gutta-Percha, and Telegraph Works Company), the objects of which were to form an extension of the Spanish National Company's system on the one hand, and, on the other, an alternative competing line for the Brazilo European traffic. This was to be effected by means of a cable between Senegal, west coast of Africa, and Brazil. The cable was constructed and laid the following year by the Silvertown Company. It extends from St. Louis, Senegal, to Pernambuco, Brazil, and touches at the island of Fernando de Noronha *en route*. The last section (about 350 nautical miles in length) was furnished with india-rubber core, instead of gutta-percha, the locality being considered a suitable one for giving india-rubber a fresh trial. The main part of this line passes through one of the greatest depths in which any cable actually rests,—*i.e.*, 2,830 fathoms, lat. 9° 53′ N., and long. 21° 24′ W. At Pernambuco this company's Africo-American system meets that of the Western & Brazilian, and also that of the Brazilian government land lines, thus gaining access (by agreement) to all the principal Brazilian towns as well as to the rest of the South American continent.

In 1893 the Europe and Azores Telegraph Company was established to effect telegraphic communication between Lisbon and the Azores group. This company is worked on a subsidy from the Portuguese government; indeed, the cable is almost exclusively a Portuguese national affair, the company simply acting as government agents in the matter. It was laid for them by the Telegraph Construction Company in the same year, and connected two of the islands, Fayal and San Miguel, with one another and with Lisbon.

In 1894 two more additions were made to the list of Atlantic cables—one on behalf of the Commercial Cable Company, and the other for the Anglo-American Company. The new Commercial line was constructed and laid by Messrs. Siemens Brothers, and the Anglo cable by the Telegraph Construction Company. Special arrangements were made, in the design of both these cables, to meet the requirements of increased speed. Since the successful application to submarine cables of various modifications of Wheatstone's automatic transmitter (intended only for land telegraphy), the limit to the speed attainable depends, practically speaking, only upon the type of cable employed. In a general way, therefore, it will be readily understood that, if funds are available at the time for the construction of one cable which will do the work of two, a notable economy is the result. On these principles, the core of the new Commercial cable was composed of a copper conductor weighing 500 pounds per nautical mile, covered with a gutta-percha insulating sheath weighing 320 pounds per nautical mile, while the new Anglo has a core with conductor weighing 650 pounds per nautical mile, and gutta-percha insulator weighing 450 pounds per nautical mile, involving a completed cable (main type) nearly double the weight of previous corresponding lines. The actual speed (simplex) obtained by automatic transmission with the latter cable is as high as forty-seven (or even up to fifty) five-letter words per minute. On the previous lighter Atlantic cores twenty-five to twenty-eight words per minute was the usual maximum speed attainable; the former, say, by average manual transmission and average receiving, and the latter by automatic transmission.

As a part of the union between the old world and the new, there are altogether fifteen cables at the bottom of the north Atlantic. Out of these, eleven are now working, all of which have been laid since 1872. Yet another Atlantic cable from France to the United States is now being laid at the instigation of the French, and with the assistance of the Silvertown's Company's ships and staff.

Two distinct lines, one of which is duplicated, now unite Europe (directly) with the South American continent and all its branch lines, thus indirectly giving additional lines of communication with the West Indies and North America.

A noteworthy void is observable in the north Atlantic, between the Azores and Bermuda, which, if filled, would constitute another Atlantic cable, and thus an additional highway between Europe, on the one hand, and the United States and Canada on the other. A still greater blank occurs between Mauritius and Australia, which might profitably be made good, so as to create an extra line to the latter country. Another useful extension would be that of the Central and South American cables up to San Francisco. How soon the greatest gap of all—namely, that across the Pacific ocean—will be spanned it is impossible to predict, but there seems every probability of a new line of communication being established by the pioneer allied telegraph companies more directly with the Cape and hence on to Australia. It is proposed that this line should touch only British territory. The above scheme should meet all political requirements, besides affording every security within reason.

It remains to be said only that far more capital is at present invested in submarine telegraphy than in any other branch of electrical industry, amounting to some forty-five millions sterling.

THE APPLICATION OF ELECTRIC POWER TO PUMPING MACHINERY.

By S. H. Bunnell.

ONE of the most salient characteristics of the times is the extension of labor-saving methods throughout the entire range of human activity—the emancipation of manual labor from the drudgery of the ordinary tasks of life and industry. Among these, the pumping of water is by no means the least, and it has attracted its full share of attention. The ancient inventor first increased his possible lift by fastening his rude bucket to a sweep, with a counterbalance. As he learned the use of animal power, he attached his buckets to the rim of a wheel to secure continuous action. As the sprocket chain is a derived form of gear, so the chain pump is derived from the rude scoop-wheel. It is impossible to enumerate the various forms of ancient pumps; but the reciprocating piston pump was early conceived, and has monopolized most of the pumping of the world to this day. To these two ancient forms, we must add two rather modern ones—the rotary-gear pump, employing specially-shaped gear-teeth to move the water, and the marvellously simple centrifugal pump.

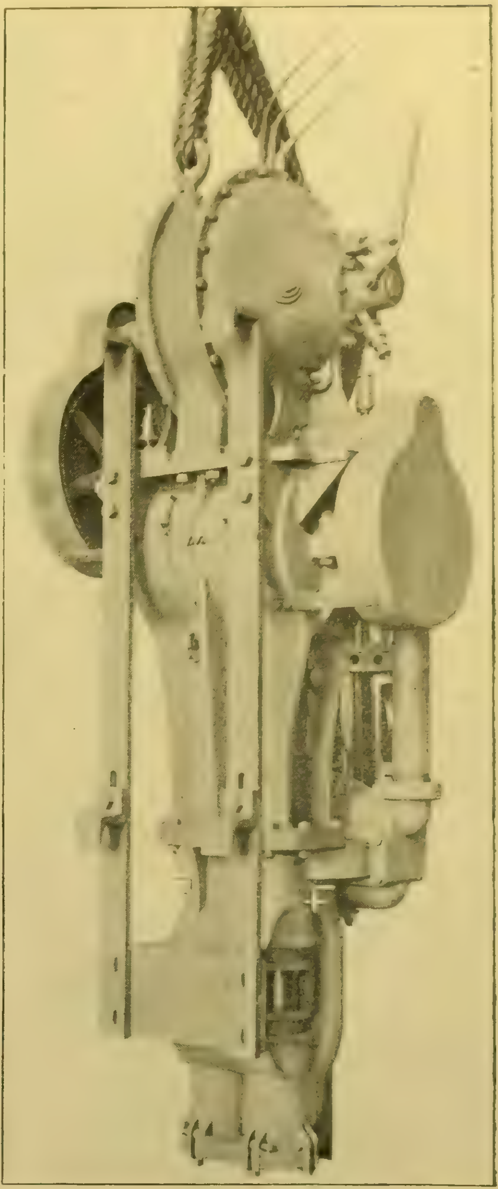
These four classes cover nearly all the pumps in use for every purpose. The chain pump is employed only to a limited extent, and is generally worked by hand. The rotary-gear pump is used where the rotary feature combined with positive action is valuable, efficiency being of secondary importance,—as in pumping oil to flood metal-cutting tools, or in fire service by an ingenious and well-known form of fire-engine. The other types are of far wider application, and divide the field, the centrifugal pump being used where the head is low and efficiency not of the highest importance, and the reciprocating taking all other cases.

The term "power-pump" seems the opposite of "hand-pump"; but, as a matter of fact, this term is restricted to a pump driven by a rotating shaft, and is used in distinction to "steam-pump" or "pumping-engine," which consist of steam-engine and pump in one framing. Wherever conditions require the use of motive power other than steam directly applied, the power-pump is employed. It is the purpose of this article to point out a few of the conditions under which electricity is the most desirable motive power, and to discuss, from the purchaser's point of view, the advantages of some of the types of pumps especially designed to be electrically driven.

It is the custom among a certain class of engineers to condemn unsparingly the small direct-acting steam-pump as the acme of wastefulness. While undeniably the consumption of steam in these machines is large, if measured by the performance of high-duty expansive steam-engines, yet, if they are properly credited with their convenience, compactness, reliability, durability, cheapness, and, in short, their general fitness for the service intended, their disappearance seems a long way off. There are, however, certain conditions under which the power-pump has the advantage. In the effort to attain greater economy in driving small machines, it is becoming the custom to locate a large prime mover in some suitable place, and to transmit its power by proper means to the driven machinery, thus deriving the benefit of using energy developed by large prime-movers under the best conditions. It is in such cases that the power-pump is used; and, while belt-transmission from a line-shaft is convenient, where possible, and compressed-air has a wide field of its own, electricity presents certain advantages over any other connecting link from power-plant to small machines.

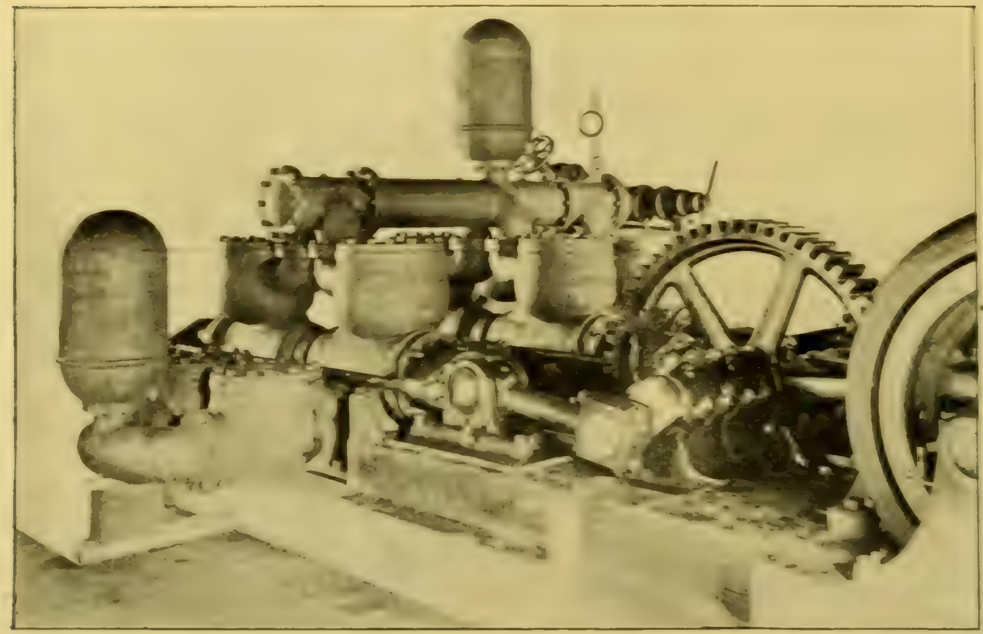
The electrically-driven power-pump is generally desirable where one or more of the following conditions exists: first, where the use of steam direct would be more expensive, or objectionable; second, where electric energy is being generated for other purposes; third, where electric energy can be cheaply purchased.

Under the first condition fall places remote from fuel-supply, or difficult of access, but where convenient water-powers exist, which, at a reasonable outlay, may be developed, and employed through power-transmission to do the necessary work at the desired point. The greater the distance between motor and work, the more does electricity possess advantages in convenience and cheapness of application and economy of operation over rope-driving or transmission by compressed air. If difficulty of access hinders the bringing of coal to boilers, it may be possible to place the boilers at a point more convenient to the fuel-supply and to transmit the power, as from the supposed water-fall. This might be done in a very hilly location, or along navigable waters, where one handling of fuel would be saved. Pumping in mines sometimes falls under this first condition; badly-planned and neglected steam-pipes often deliver more water than steam to the pumps, and, by dripping from leaks, cause decay of wood-work around them. Here electricity and compressed air present certain advantages over steam; but, except that the exhaust from compressed-air motors assists the ventilation of the room containing the machinery, there is nothing to be said in favor of the use of air that does not apply with greater force to electricity. In the case of stationary pumps, wires take less room than pipes, and are much less liable to derangement, while for temporary track or sinking pumps, the convenience and rapidity with which the wire connections may be made are of great advantage. There are many situations above ground, where the same conditions operate to suggest the use of electric motors, and where compressed air cannot offer its capacity as a ventilator as a reason for its use.

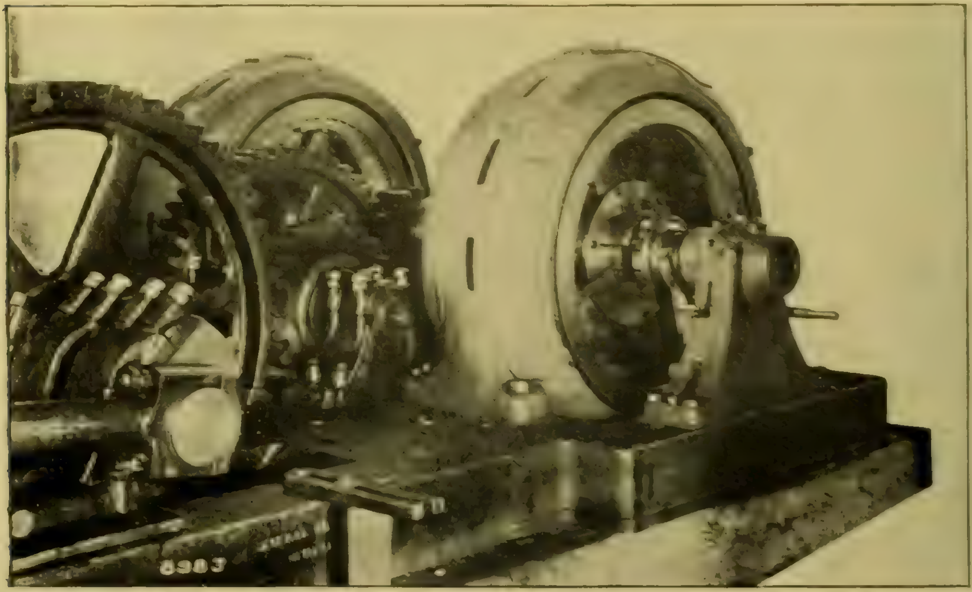


KNOWLES 5 X 6 DUPLEX SINKING-PUMP, WITH 20-H.P. GENERAL ELECTRIC INDUCTION MOTOR; PACHUCA, MEXICO.

Under the second condition falls the necessary pumping in electric-light and -power stations, where large and efficient engines are in use to drive the dynamos. Here electric-power pumps have no competitor. For the auxiliary pumps of such steam plants they are peculiarly suited. A single machine with several cylinders may be used for several services at one and the same time, thus perhaps concentrating all the pumping at one point, where it can be easily regulated. In places where there are line-shafts, belted pumps may be preferred; but few modern power-houses employ line-shafts. Large city buildings having private lighting-plants may use with advantage electric pumps for their water supply and for elevator-service, the hydraulic elevator being still in the lead of the direct electric, though possibly soon to give way. There are also factories with generators in use, metallurgical and chemical establishments using electric processes, and extensive plants with electric transmissions between buildings, where current for the operation of pumps is at hand, and where quietness, compactness, efficiency, and reliability are strong arguments in favor of this type.

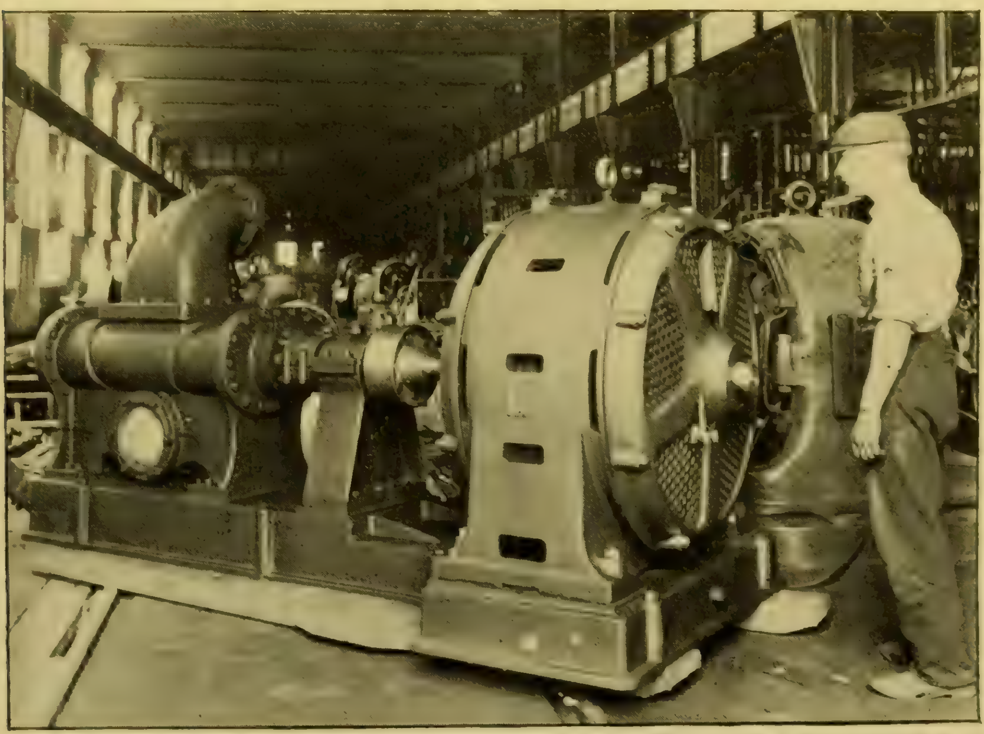


Falling under the third condition are some very small and some very large pumping plants. Pumping for house-service, as in suburban or high locations, where current for incandescent light is at hand, is effected by a small, automatically-controlled pump in the basement. The pumping for a whole city may be done by electric motors, as at DeKalb, Ill., Austin, Texas, and other places. Proposals have been called for by several cities for such pumping plants. Not long ago



TWO VIEWS OF WORTHINGTON 10 X 12 TRIPLEX PUMP WITH TWO GENERAL ELECTRIC INDUCTION MOTORS, INSTALLED BY CIA. DO BOA VISTA, BRAZIL.

Buffalo, New York, considered seriously the purchase of a thirty-million-gallon power-pump to be driven by power from the famous plant at Niagara Falls; though a steam pumping engine similar to another in place was finally purchased, the decision was made for other reasons than doubt of the economy and reliability of the proposed power-pump. The arguments for and against were extensively discussed in the local press. The only requisite in the case of water-works-pumping is reliable electric power at a cost as low as that of the same amount of steam-power, and sufficiently controlled by the corporation operating the pumps.

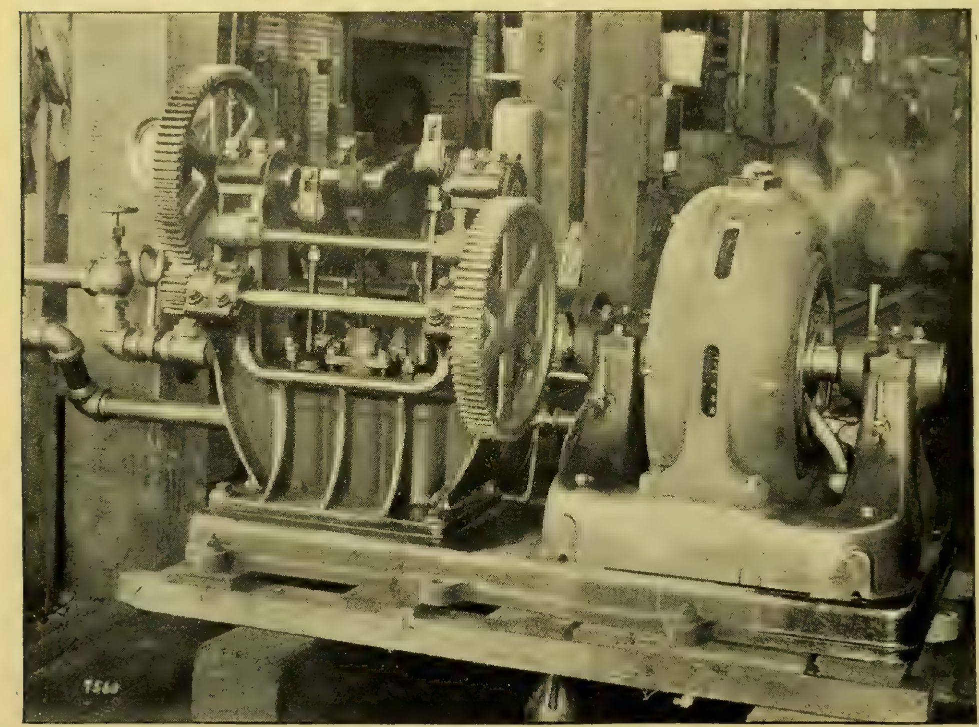


75-H.P. WESTINGHOUSE MOTOR DRIVING QUIMBY PUMP; UNITED SMELTING & REFINING CO., PRICKLY PEAR JUNCTION, MONT.

A search of periodicals and catalogues shows that the electric plunger and piston pumps built and advertised to date cover a wide range in size and service. Self-contained house-service pumps of a capacity as small as fifty gallons per hour are built by several well-known makers. They are often belted to the motor to avoid the noise of gearing. Larger pumps are duplex or triplex, vertical or horizontal, according to conditions of service, and are generally geared to the motor. The self-contained machine is convenient, but the purchaser must not think that he can set it "anyhow" on its foundations, and expect good results. The best machinery may be spoiled by careless treatment.

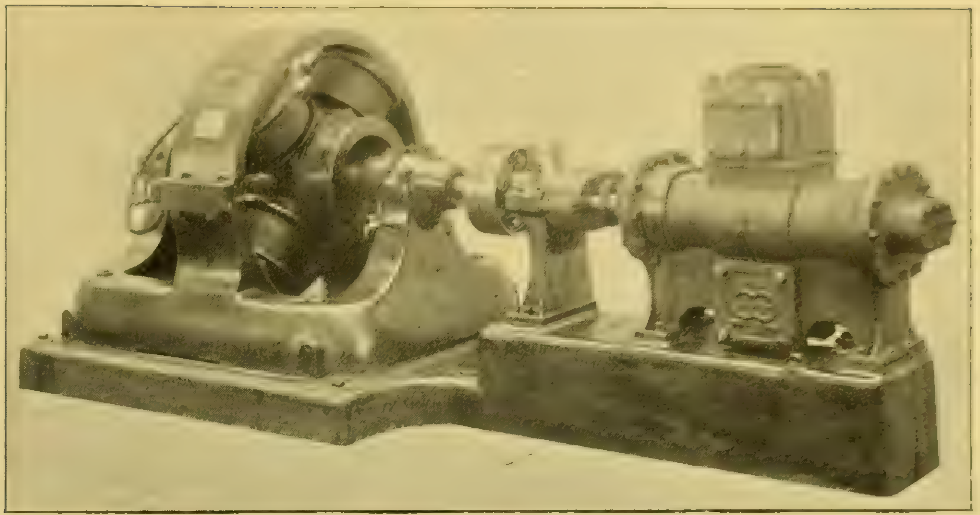
Vertical pumps are offered for low service by all makers, where conditions of space allow, as there is less friction loss. In the favorite type the connecting-rods are journaled on pins near the bottom of its single-acting trunk-plungers. Horizontal single-acting pumps are offered for heavier pressures, and double-acting for larger capacities. Several good track and sinking pumps are on the market, designed to suit their peculiar conditions. For low service the rotary types are often useful, and they are peculiarly adapted to driving by motors.

The rotary-gear pump has not yet appeared with motor drive. It might be found useful as a fire-engine, to take power from neighboring trolley wires, or for other special service. A curious form, consisting of two similar parallel square-thread screws meshing one with the other, and forcing the liquid contained in the spaces between the threads in a direction parellel to the axes of the screws, has been for some time on the market.



KNOWLES VERTICAL TRIPLEX PUMP WITH GENERAL ELECTRIC INDUCTION MOTOR.
CIA. DO BOLIO, SANTA ROSALIA, L. C.

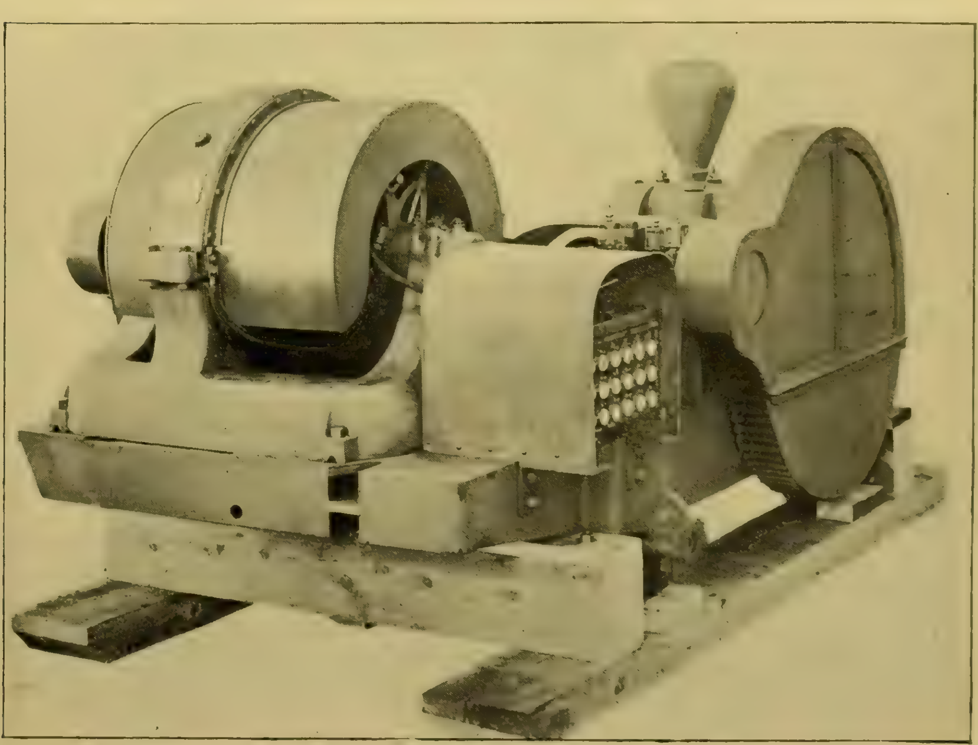
Large pumps for waterworks are of the regular designs. They are geared to motors instead of turbines; otherwise, the arrangement is the same. Vertical pumps are often demanded, to get within range of suction-lift from supply, but of these no definite class is yet developed. As with steam-pumps, each problem is worked out to suit its own conditions.



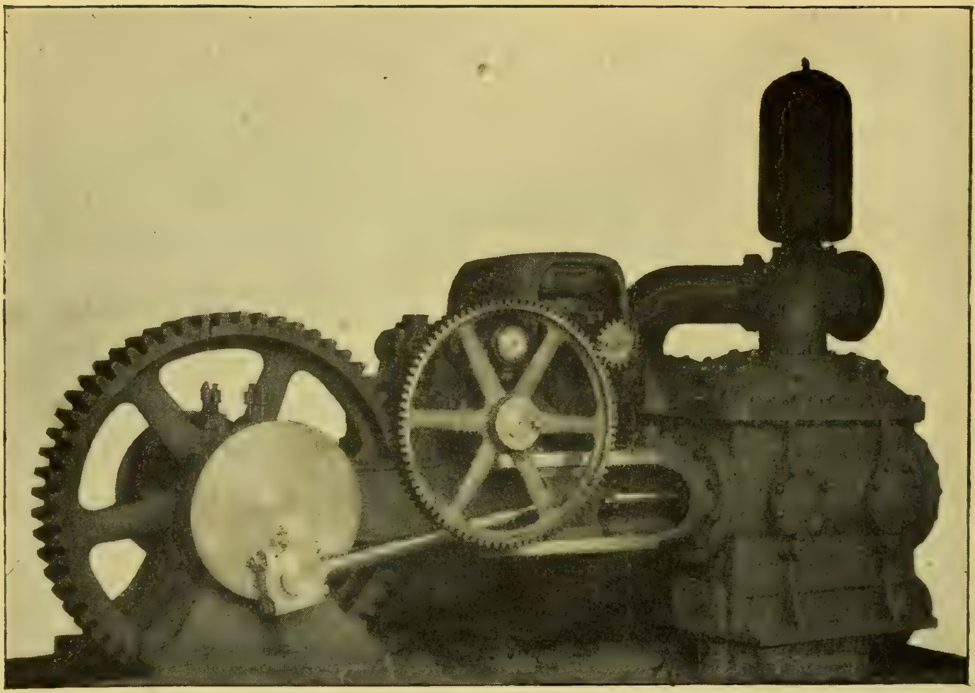
QUIMBY SCREW PUMP WITH 20-H.P. GENERAL ELECTRIC MOTOR.

The purchaser may obtain his electrically-driven pump through either the large electric companies or the prominent pump-manufacturers, or he may buy the two machines separately and combine them himself. It is probably best to allow one manufacturer to furnish the set, and thus get the benefit of careful adaptation of pump to motor.

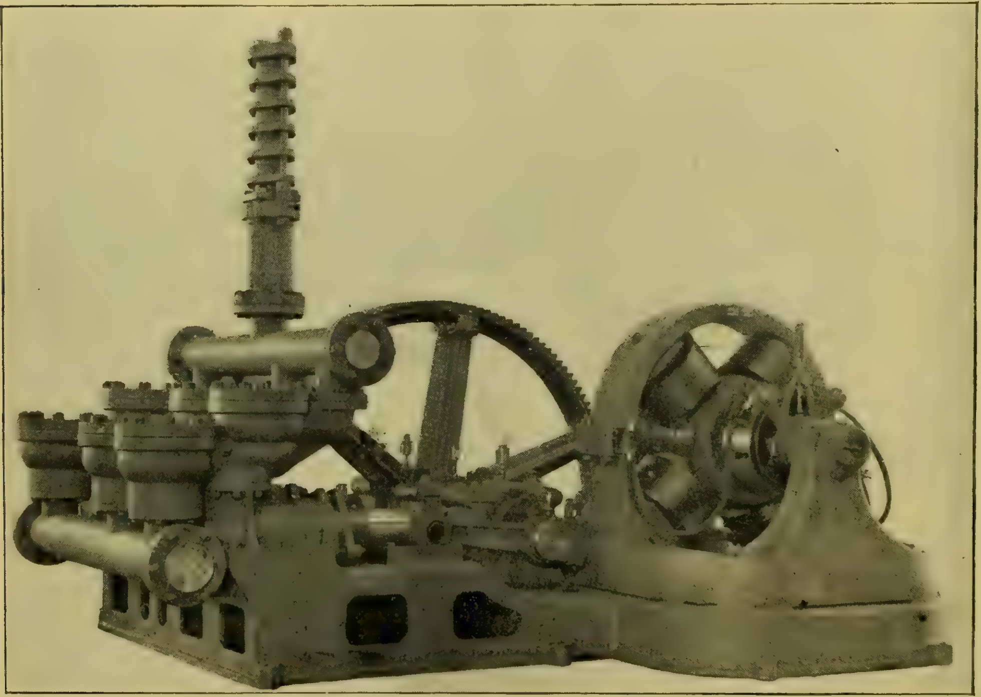
While the fundamental principles of design are the same in all



6½X8 HORIZONTAL TRIPLEX TRACK-PUMP, WITH 10-H.P. GENERAL ELECTRIC MOTOR; YOUGHIOGHENY RIVER COAL CO., SCOTT HAVEN, PA.



14X18 BARR PUMP, CAPACITY 1500 GALS. PER MINUTE, WITH EDISON MOTOR; SAULT ST. MARIE, MICH.

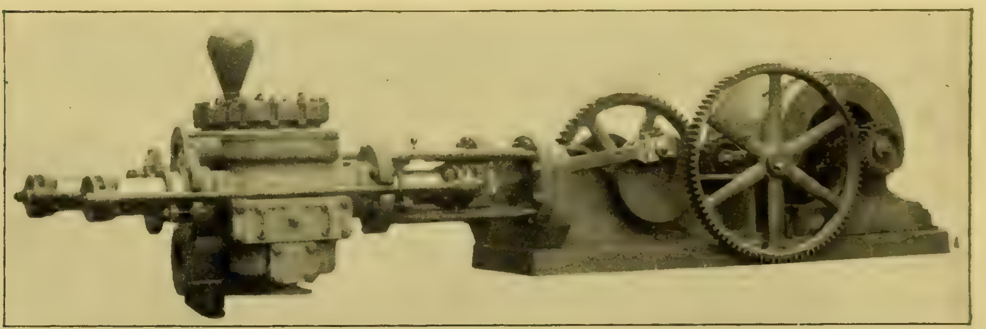


KNOWLES 6½X8 SINGLE-ACTING HORIZONTAL TRIPLEX PUMP WITH 50-H. P. SLOW-SPEED MOTOR; CATORCE, MEXICO.

pumps, the proper departures from established precedents necessary to meet new conditions are best decided by the application of the wide experience gained in the manufacture of the most successful pumps and electric machinery, rather than by a readiness to try every new idea.

The early motors ran very fast, requiring great reduction of speed by the transmission organ, whether belt or gears, to enable them to drive the usual line shaft or machinery. Designers have overcome this trouble, and offer low-speed motors, which may be connected by convenient, simple, and sightly means to the shafts to be driven, the increased floor-space required for the motor being partly compensated by the compactness of the transmission, and part of the increased first cost by the saving in friction-loss and noise.

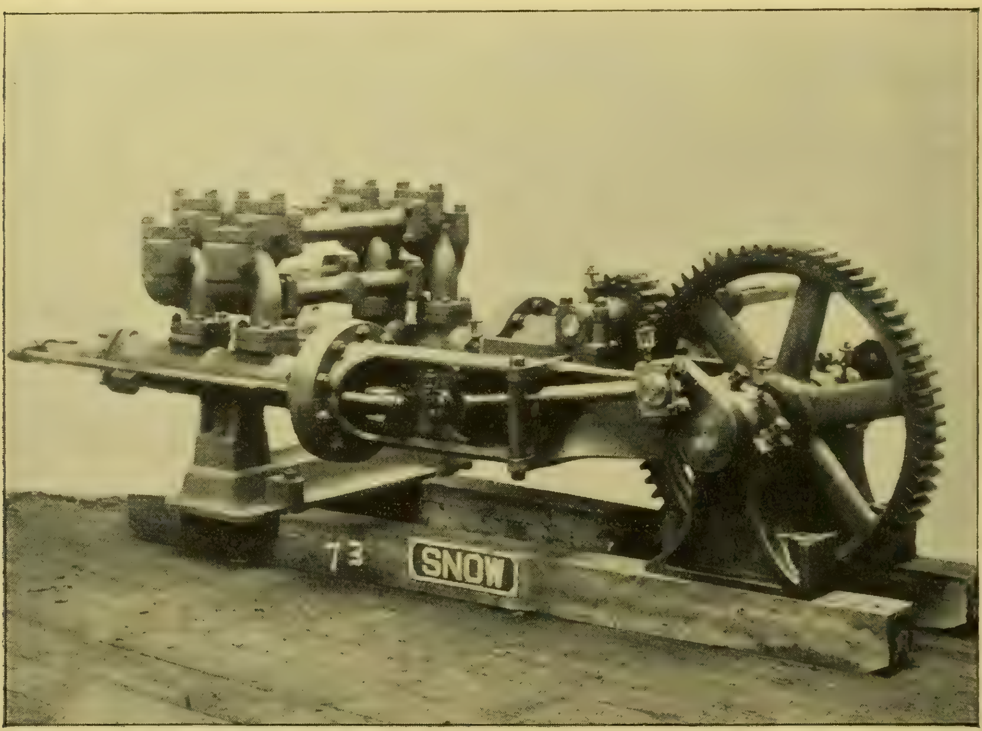
The type of pump is selected with reference to the service, as previously outlined. The machine must be carefully designed for strength; for, while the steam-pump is itself a very efficient alleviator of shocks or water-hammer, the crank-pump receives such shocks on its rigid metallic connections. All pocket-books and pump literature state that the waterways through the pump should be of ample area, that air pockets should be avoided in suction-pipe and pump-chamber, and that efficient cushioning devices should be provided. A maximum speed of water through valves of not more than two hundred feet per minute, and valves of low lift, are also advised. But none of these are hard and fast rules, and they are often set aside; the purchaser must depend on the ability of the manufacturer for the success of his pump.



JEANESVILLE 5x8 DUPLEX PUMP WITH 7-H. P. SLOW-SPEED GENERAL ELECTRIC MOTOR; DERRY COAL CO., DERRY, PA.

The simplicity of the triplex single-acting plunger pump, with its single set of valves for each plunger, is commendable. The objections to this pump are the three points of maximum resistance in each revolution of the crank-shaft, and consequent greater fluctation of turning effort, as compared with the six maxima per revolution of the double-acting type; also the generally larger parts of the single-acting pump, for a given capacity. The differential plunger is single-acting as regards its suction and discharge valves, while double-acting as regards the effort on crank-pins due to discharge-pressure, and is thus a good compromise, in spite of slightly greater complication. Convenience of overhauling and means of getting at valves, and provision for taking up wear, are good points. A stiff, one-piece crank-shaft is desirable, and, unless very short, it should have bearings at each crank.

Belt-connection between pump and motor is used in small sizes. The usual and preferred practice is to employ gears,—a single reduction, if possible, cut teeth, fine pitch, wide face, and carefully set.

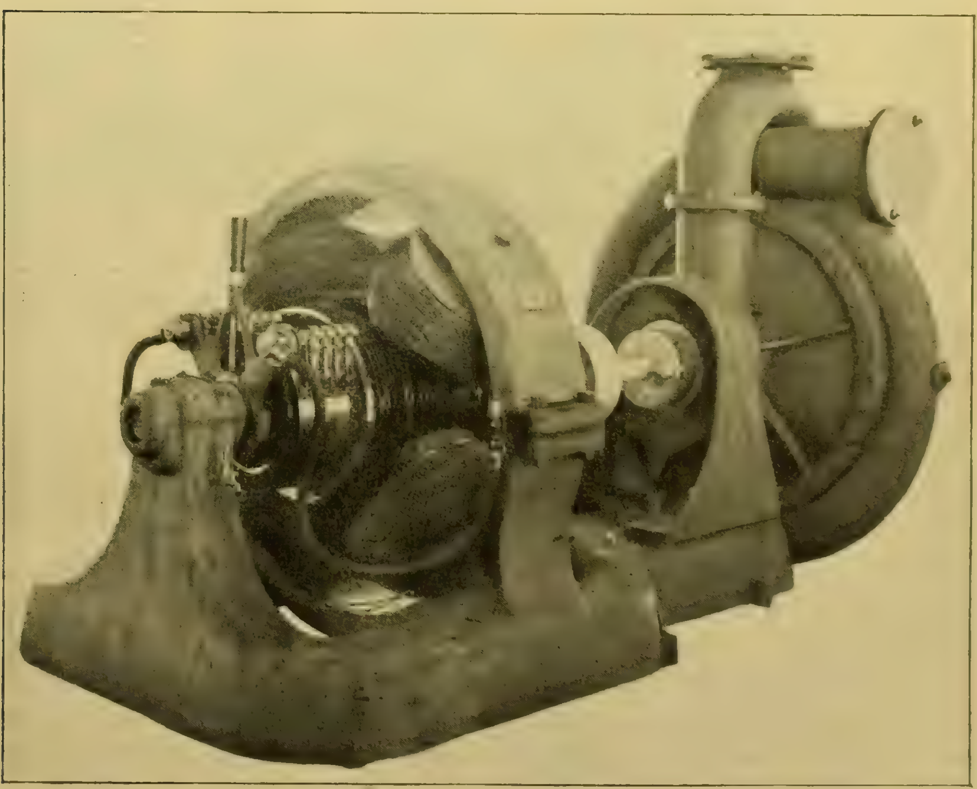


SNOW 2½ X 2½ DUPLEX PUMP FOR 1000–2000 LBS. PER SQ. IN. PRESSURE, ARRANGED FOR ELECTRIC DRIVING.

Rawhide pinions are furnished, where necessary, to reduce noise, and steel gearing where great strength is needed.

The centrifugal pump possesses one advantage over the reciprocating pump, when electrically driven, in that it may be directly coupled to the motor. These pumps do not compete to any great extent with the plunger type, for they find their field where the head is very low, as in draining land, emptying docks, circulating liquids, or raising sewage, or in dredging and wrecking operations, where the pump must lift and pass sand, stones, coal, and anything else that may happen to get in the way. They are cheapest of all in first cost, for the amount of water handled, but not always cheapest in opera-

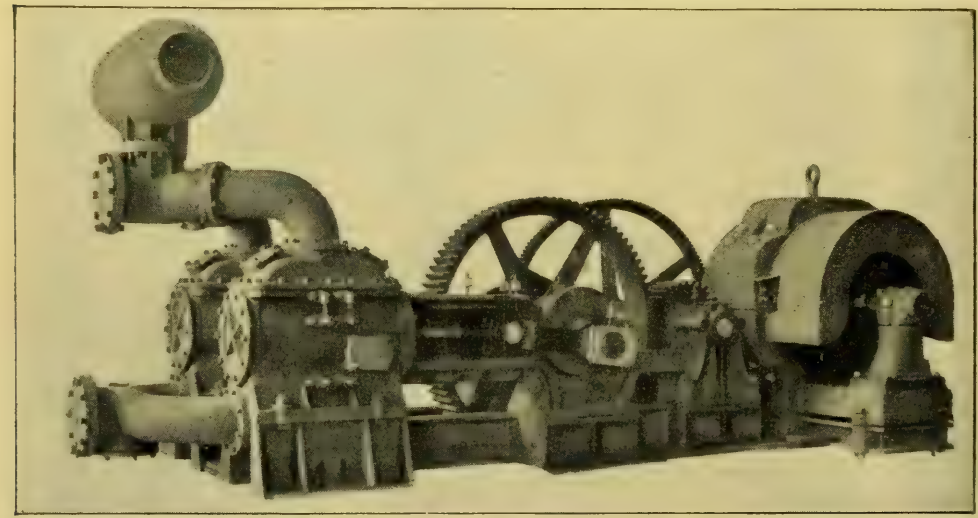
CENTRIFUGAL PUMP DRIVEN BY 20-H.P. WESTINGHOUSE MOTOR. DE LA MAR MINE, MERCUR, COLO.



LAWRENCE CENTRIFUGAL PUMP AND 4-POLE 60-H.P. 550-VOLT GENERAL ELECTRIC MOTOR; CATARACT CONSTRUCTION CO., NIAGARA FALLS, N. Y.

tion. Comparing the reciprocating pump with the centrifugal, it may be said that the former is an enlarged portion of a water-pipe, through which the liquid flows at a reduced and fluctuating speed, while the latter is a contracted portion of the pipe, through which the water flows at an increased, but uniform, speed. There are no shocks from water-hammer to guard against, and no valves of any kind except the foot-valve to hold the suction, used where the pump has to lift a considerable distance.

The usual electric motor has a horizontal shaft ; hence the vertical centrifugal pump is not as well adapted as the horizontal to this drive. Where the suction is taken at one side only, there is an end-thrust on the shaft, which must be resisted by some form of thrust-bearing. With the forked suction-pipe this is avoided, but it is impossible to get as easy curves in the piping, and the crotch offers a place to catch sticks or other *débris* in the water. Another way of balancing is to pass half the water through the central blade of the wheel, and, by having vanes on both sides of this, to do half the pumping against the back of the casing of the pump. This arrangement permits removal of the wheel through a cover on one side of the case. The capacity and head vary with the speed of the pump, so that the amount of water pumped cannot be measured by a revolution-counter.



9½ X 12 DEANE DUPLEX PUMP WITH 110-H.P. GENERAL ELECTRIC MOTOR; COLORADO FUEL & IRON CO., ROUSE, COLO. CAPACITY 1,000,000 GALS. IN 24 HOURS. WATER PRESSURE 150 LBS.

There is thus one more field in which electricity will, to some extent, displace the small steam-motor. With the manufacturers of pumps and motors working in harmony, we may expect to see the rapid development of other electric devices to their present excellence repeated in the case of the electrically-driven power-pump.

THE TIMBER WEALTH OF PACIFIC NORTH AMERICA.

By Frank Haines Lamb.

THE enormously wide and rapid growth of the use of steel, as a material of construction, has tended to cast the shadow of subordination, if not the suspicion of discredit, upon the older material, wood. Its actual position, however, is not one of impending disuse, but of modified (and more intelligent) use. It would only parallel phenomena observed in other lines of engineering progress, if the new order, which at first seems to threaten the old, should eventually enlarge it, and wood, in a somewhat different range of applications, should be even more extensively employed through the larger works which steel has made possible.

The countries of Europe where little lumber is available have long drawn upon the forests of eastern British America and the United States. Now, the opening of the east, the extension of railways in China, the growth of mining in south Africa—all afford markets directly tributary to the Pacific coast of North America, from the Northwest Territory through British Columbia into Oregon, Washington, and California. The distances are great, and reckless methods of lumbering in the past have to be paid for by increased difficulties to the present mills; but improved methods of transportation, such as those recently described by Mr. Bishop in THE ENGINEERING MAGAZINE, combined with improved and more economical methods of felling, the application of mechanical means to reduction of labor costs, and more careful study and discrimination in the selection and utilization of different woods—these offer great opportunities which appeal most strongly to the lumber interests of extreme western Canada and the United States.

These regions are dependent, primarily, upon the distribution of the various species of lumber-producing trees, and, secondarily, upon the accessibility of these areas to the markets of the world. The timber trees of the Pacific coast belong, with but few exceptions, to the *Conifers*, or cone-bearing trees. In California and southern Oregon are forests of various species of oaks, and along all streams are different species of cottonwoods, alders, and maples, all of which yield a timber which could be utilized in many industries; but these remain almost entirely undeveloped.

Taking into account the principal timber-producing cone-bearing trees, we immediately recognize as most important and most widely distributed the Douglas fir,[*] which masquerades under a great variety of common names. Lumber merchants are familiar with it as Oregon pine, when the lumber comes from Oregon. In Washington it is commonly known as fir, or Douglas fir. This species has an unbroken distribution from the British Northwest Territory to Lower California and from the seacoast to the Rocky mountains. It is extensively lumbered only in British Columbia, Washington, and Oregon. This tree, in size, is second only to the California redwood. The trees now cut for market range in size from 26 inches to 100 inches in diameter, the average being from 60 inches to 72 inches. In the forests this tree reaches a height of from 150 feet to 300 feet, and under the best of conditions logs have been obtained 125 feet in length with a diameter of 36 inches at the smaller end. From this tree bridge timbers 110 feet by 8 inches by 16 inches have been obtained, perfectly free from knots, pitch rings, or imperfections of any kind.

Owing to our imperfect knowledge of the properties of American woods, all statements are liable to modification in the light of further investigation. Tests made by the division of forestry, United States department of agriculture, on various species of cone bearing trees established the superiority of Douglas fir to all others. In the transverse strain, test sticks 1.5748 inches square, resting on supports exactly 39.37 inches apart, were used. Under a strain of 1,213.53 pounds this species gave a deflection of 1.753 inches and an ultimate strength of 1,238.98 pounds, while northern white pine, under 661.38 pounds' pressure, gave a deflection of 2.4427 inches and an ultimate breaking strength of only 756.17 pounds. In order to produce an indentation of 1.851 inches it required, on Douglas fir, 45,304.5 pounds' pressure; to produce the same effect on northern white pine it required but 13,900 pounds.

The Northern Pacific Railway Company tests for bridge purposes showed that a stick 4 feet by 2 inches by 4 inches, laid on supports 3 feet 9 inches apart, required for its fracture a center load of 4,320 pounds, while eastern white pine required only 1,610 pounds and a stick of green eastern oak but 2,430 pounds. Various other tests have been made, all proving that the transverse breaking strength of Douglas fir is equal, if not superior, to that of the best eastern oak. Government tests give the specific gravity of air-dried specimens as 0.5157; ash, 0.08; and weight per cubic foot, 32.14 pounds.

Next to Douglas fir, the California redwood[†] is best known and most extensively manufactured. It grows in a belt parallel to the coast and not exceeding fifty miles in width, from the northern boundary of California to near Monterey, south of the bay of San Francisco, —in all, a length of about 300 miles. It forms nearly pure forests on the moist, fog-laden coast ranges. The redwood is a very soft timber of coarse grain and a brick red color, which is very bright when freshly cut, but soon becomes dull when exposed. It does not warp or shrink, and does not readily ignite.

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[*] *Pseudosuga taxifolia.* [†] *Sequoia sempervirens.*

According to tests made at the University of California,* a green beam 200 inches long, 3.84 inches thick, and 5.60 inches high broke under a center dead-weight of 19,610 pounds. A seasoned stick 200 inches long, 4.02 inches thick, and 16.15 inches high, broke at 25,440 pounds. For all construction purposes where strength is not required, and for shingle and interior finishings, it is excellent.

North of the California-Oregon line there are two timbers of more recent introduction, both of which are being well received in the markets of eastern America. Extending in a narrow belt, in no place over twenty miles in width, along the coast from south-eastern Alaska to Coos Bay, Oregon, is the tideland spruce.† On the western coast of Washington, where it reaches its perfection, it forms from 25 to 75 per cent. of the forest cover. In size it equals Douglas fir. The trees growing in the dense woods are remarkably straight and clear, while those growing in open places are covered with limbs to the ground, and are of no commercial value. The wood is nearly pure white, without pitch, odor, or taint ; it is very tough, and, when worked with sharp knives, it takes a good finish.

Its transverse breaking strength is almost equal to that of the white pine of the eastern United States ; its deflection is only about half as great. Its specific gravity is less than that of any other cone-bearing tree yet tested,—0.3449. The weight per cubic foot is only 21.49 pounds. Since it can be artificially dried, it is peculiarly adapted to long shipments on account of the low freight weight.

With a somewhat similar north and south extension, but extending from the coast to the Cascades, is found the Pacific coast red cedar.‡ Like the tideland spruce, it rarely forms a forest growth by itself, but is nearly always present, forming from 10 to 50 per cent. of all forests. Its headquarters is about Puget sound and along the coast of Washington. This wood also has a low specific gravity (0.3796), and weighs 23.66 pounds per square foot. In color it much resembles the redwood ; it has a strong odor and taste ; its grain usually is coarse. In transverse strain tests it equals white pine, and is superior to it in compression tests.

Scattered throughout the dry interior valleys and on the higher foothills of California and southern Oregon are limited quantities of the sugar pine.* This is an excellent white lumber of great strength, taking a good finish. Extending over a very limited area at Coos bay is the Port Orford cedar,† while crowning the mountain summits of Washington, British Columbia, and reaching down to the coast in Alaska, is its sister, the Alaska cedar,‡ or Sitka spruce. These two trees, so little known in the market on account of their scarcity and inaccessibility, are the most valuable of all the Pacific coast trees. They are probably the strongest and toughest of all the conifers, and take the finest finish.

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* Pacific Coast Wood and Iron. Vo. XXVII. No 5.

† *Picea sitchensis.* ‡ *Thuja plicata.*

Along the western flank of the Sierras, extending from California, are scattered the score or more groves of the Big Tree.§ The total area of these groves originally did not exceed 35,000 acres. Many are as yet untouched, but in the more accessible the saw-mill is eating them away. The lumber almost identically resembles the redwood,—the apparent differences being that it is perhaps a shade redder in color, and of coarser grain.

On the dry interior valleys and foothills of California and east of the Cascades, on the plains and hills of eastern Oregon, Washington, and Idaho, are many large tracts of the yellow pine.|| Much of this is lumbered to supply local demand and for mining purposes. It is in every way an inferior lumber, and will not take any large part in the future of the lumber trade. In the southwest, on the mountains of Oregon, in the celebrated Coconino forest, grows the Arizona yellow pine. This is destined for a similar fate,—that of supplying local demands for ordinary lumber.

The western hemlock¶ has a general distribution west of the Cascades, extending from southern Oregon into British Columbia. This tree does not reach the immense size of its companions in the woods, but further tests will reveal its superiority for many construction purposes, the timber being far superior to the hemlock of eastern America. In addition, it possesses a very beautiful grain, and readily takes a beautiful finish. Owing to its great weight, green logs do not readily float. As long as logging operations depend upon water, it will not be cut. At present the wholesale waste and destruction of this timber, incidental to the cutting of the fir, cedar, and spruce, is the greatest crime which can be laid at the doors of the lumberman of the Pacific northwest.

This completes the list of those trees that have found their way into commerce. In the future many other species will, in limited quantities, be lumbered.

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* *Pinus lambertiana.* † *Chamæcyparis lawsoniana.* ‡ *Chamæcyparis nutkatensis.* § *Sequoia gigantea.* || *Pinus ponderosa* and varieties. ¶ *Tsuga mertensiana.*

Along tidewater, from British Columbia southward about Puget sound, the Columbia river, and thence south to San Francisco, or wherever a railroad line has penetrated into these belts of virgin timber, saw-mills have arisen.

Beginning on the north, the international line separates the mills of British Columbia from those of Puget sound. Fir is the chief lumber produced, cedar being second. The latter, however, is almost exclusively confined to the production of the red cedar shingles. The chief mills are located at Chemanus, Vancouver, Moodyville, New Westminster, and Victoria. It is estimated that there are five hundred thousand acres of timbered land in the province. Of this one-fourth is owned by one company. The mills and the methods of manufacturing resemble almost exactly those of Washington. At present the logs cut do not supply the mills of the province, and last year logs were towed two hundred miles from Puget sound.

First in importance of all the lumbering regions of the Pacific coast is Puget sound. This great inland water-way, with its multitude of excellent harbors and its intricate network of deep-water bays and inlets, affords ideal situations for manufacturing establishments of all kinds. Bordering the water on all sides are almost continuous forests of virgin timber. On the gravel plains close to the sound the timber is mainly Douglas fir, of medium size and quality, as a result of frequent burnings; but on the slopes of the Cascades and Olympics, facing the sound country, are vast forests never touched by fire.

Hardly a town of the sound region that is accessible is without a saw-mill of some sort. There are about three hundred mills of all descriptions, making lumber or lumber products. The largest mills are located at Tacoma, Port Blakely, Port Gamble, and about Bellingham bay. Following are some statistics regarding the largest mills:

Name of Plant.	Daily Capacity 10 hrs.	Lumber Manufacturing, 1897	No. Employed.	Location.
Port Blakely Mill Co.	300 M.	97,000,000	800	Port Blakely.
Puget Lumber Co....	225 M.			Port Gamble.
	175 M.			Port Ludlow.
St. Paul & Tacoma Lumber Co.......	175 M.	58,424,126	600	Tacoma.
Stimson Mill Co	150 M.	41,320,322	200	Ballard.
Tacoma Mill Co.....	250 M.	57,810,000	250	Tacoma.

Nearly the entire lumber production of the Puget sound mills consists of Douglas fir. Spruce is not obtainable, hemlock is allowed to waste in the woods, and nearly all the cedar is consumed in the manufacture of the well-known Washington red-cedar shingles.

The shingle mills of Puget sound are almost as numerous as the lumber mills; indeed, most of the large lumber plants have a shingle department. One plant at Tacoma has a capacity of 600 M. daily, and more than fifty have a daily capacity exceeding 100 M. pieces.

Extending along the coast from Gray's harbor, Washington, south to Coos bay, Oregon, is the coast lumber region. This is the only region able to manufacture the tideland spruce. Owing to the lack of rail communication, the spruce woods of Oregon are, as yet, little developed, but in Washington both Gray's and Willapa harbors have direct communication by rail with eastern markets. As a consequence, numerous mills have sprung up about these harbors, at first shipping only by water, but within the last decade finding a ready and more profitable market in the eastern States. The larger part of the lumber produced still consists of fir; the immense bodies of cedar just back from the coast are almost untouched as yet. Shingle mills have arisen like mushrooms, and already the supply of cedar is hardly equal to the demand. As a rule, these mills are of smaller capacity than that of the mills of Puget sound. On Gray's harbor there are half a dozen with a capacity of 100 M. daily, while south, along the Oregon coast, most of the mills cut from 50 M. to 75 M. daily. These are situated on Coos bay and the Coquille and Umpqua rivers, but, being without rail connections, the entire product goes coastwise to California ports. All of the coast counties of Oregon are heavily timbered, needing only development.

Portland boasts of being the king lumber city of the coast. In 1897 its ten mills cut 135,000,000 feet B. M., but its capacity is easily 200,000,000 feet B. M. yearly. The lumber manufactured is principally Douglas fir, which is known here as Oregon pine, with a little spruce box material. Logs are obtained from the Columbia and its tributaries, mainly below Portland. Contiguous to Portland are the shingle mills of the Cowlitz river, Washington. Portland's largest two plants have each a capacity of 50,000,000 feet B. M. annually.

South of the Oregon line, along the coast of California, is the redwood belt. The principal mills are situated in Humboldt, Mendocino, and Del Norte counties. From the mills the lumber is transported to the coast and then loaded into coastwise schooners for San Francisco. Owing to the lack of suitable harbors, loading is often accompanied with great trouble and danger. The schooner approaches as near as possible to a rocky cliff. A cable is shot across her bow, and down this are sent the cars of lumber. Often a storm arises, which necessitates withdrawing into the open sea, and often a schooner will lie to for days, waiting for an opportunity to load.

Lying east of the coast ranges, from southern Oregon into northern California, about the slopes of the Siskyou mountains, is a large body of yellow and sugar pine. Since the completion of the California & Oregon railroad many mills have sprung up in this section. In many cases the logs are brought from a distance and at considerable expense. The lumber manufactured goes to San Francisco.

Scattered throughout central California, along the western slope of the Sierras, are numerous mills, some like those about Truckee, supplying the demands of the large mines, others shipping into San Francisco. The lumber manufactured consists mainly of yellow pine, with some sugar and bull pines and California post cedar. Back of Fresno and Visalia, in the Sierras, are several mills that are rapidly eating away the Big Tree groves. These mills manufacture their lumber about forty miles from the railroad, to which the product is afterwards floated down a flume.

The estimated cut of all Californian mills outside of the redwood district may be given as 235,000,000 feet B. M., divided as follows: *

Yellow Pine	100,000,000
Sugar Pine	75,000,000
Douglas Fir or Spruce	50,000,000
White Fir	10,000,000

Eighty per cent. of the common product of yellow and sugar pine is used for the manufacture of boxes.

Separated as the Pacific forests are from the markets of the eastern States by two or three thousand miles of country, the coast lumber was for a long time dependent upon local consumption. From 1850 to 1870 the redwood mills of California and the fir mills of Oregon and Puget sound had to rely entirely upon the San Francisco market. That city in turn acted as a distributing point, supplying the interior cities of California.

In 1869 the first cargo of lumber was shipped from Coos bay to Hawaii, and since that time the foreign cargo business has steadily grown, until at the present time it has reached mammoth proportions, reaching almost every country and making the Pacific coast timber familiar in almost every port.

Douglas fir constitutes the principal timber sent abroad. All dimensions and qualities find a ready market, while China and Japan are now demanding large timbers for their various engineering works, now under construction. Of the total cargo shipments 163,537,944 feet B. M. was cut in Washington. The mills of British Columbia supplied sixty-five cargoes, aggregating, in round numbers, 68,000,000 feet B. M., and the redwood mills of northern California shipped

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* Pacific Coast Wood & Iron.

more than 20,000,000 feet of redwood. During 1897 three hundred and eleven cargoes were shipped from the mills of the various portions of the Pacific coast. The total shipments amounted to 275,707,060 feet B. M. Their destination is shown by the following table:

CARGO SHIPMENTS FROM PACIFIC COAST.

	1897.
Society Islands	655,656 ft. B. M.
Calcutta, India	1,065,565
South Africa	15,975,676
Europe	35,219,079
Central and South America	34,055,753
Mexico	13,994,033
Siberia	4,238,274
Hawaiian Islands	5,722,468
Honolulu	25,234,253
Japan	17,694,635
China	26,077,586
Australian Ports	76,152,560
Total	257,707,060

The indications for the coming year point to a lowering in the foreign freight rates, due to the light grain crop of California. At present the average charter prices for the principal foreign lumber export ports are as follows:

		Shillings per 100 ft. B. M.
Pacific Coast Ports.	To South Africa	65–70
	United Kingdom	60–65
	South America	35–40
	Japan China	42–45
	Australia	45–55
		U. S. currency per 1 M.
	Central America	$8.00
	Mexico	8.00
	Honolulu	7.00

The shipment of lumber by rail was made possible in 1888 by the completion of the Northern Pacific Railroad into Tacoma, thereby making direct rail communication between the mills of Puget sound and the markets of the eastern States. In 1890 systematic shipping by rail began. From that time it has constantly increaseed. Statistics for California and Oregon are not available, but a comparison of the rail shipments from Washington for the past four years will be of interest.

COMPARISON OF WASHINGTON RAIL SHIPMENTS.—IN CARLOADS.

	1894.	1895.	1896.	1897.
Lumber	4,282	5,662	6,611	7,671
Shingles	10,992	13,776	14,118	17,540

In thousand feet B. M. the shipments of fir, 1896 and 1897, are:

1896	103,836,000.
1897	122,736,000.

The entire production of red cedar shingles is confined to Washington and British Columbia. From Washington there were shipped in 1897, by rail, 2,854,400,000 shingles; besides, 6,500,000 were shipped by sea.

With the extension of the Northern Pacific to Gray's harbor in 1892 the first shipment of tideland spruce was made to the eastern States. This timber is largely used for interioi finishing and car-construction, and is becoming very popular in the market.

The following brief table of freight rates to principal points in the eastern States is compiled from the present schedules:

	Fir.	Spruce or Shingles per 100 lbs.
Puget Sound to Omaha	50	60
St. Paul	40	50
Chicago	50	60
Buffalo	65	75
New York	73	83
Boston	75	85
Philadelphia	73	83
Cleveland	62	72

No careful estimate of the actual cut of the Pacific coast mills can be given, since in many sections no reports are made. Following is an estimate based upon the best authority:

LUMBER PRODUCTION OF THE PACIFIC COAST FOR 1897.

			AUTHORITY.
British Columbia.	Foreign	68,000,000	W. C. & P. S. Lumberman.
	Rail	25,000,000	Estimate.
Washington,	Coastwise	243,522,979	W. C. & P. S. Lumberman.
	Foreign	163,537,944	" "
	Rail	122,736,000	" "
Oregon,	Portland	130,000,000	Portland Oregonian.
	Except Portland	420,000,000	" "
California	Redwood	213,249,456	Pacific Coast Wood and Iron.
	Interior Mills	235,000,000	" " " (Estimate).
	Rail	113,275,000	" " " "
	Total	1,724,321,379	Feet B. M.

Washington Shingle Output ....2,860,900,000 pieces.

The coastwise cargo trade to domestic ports still continues to demand a large proportion of the entire Pacific coast cut. Most of this goes to San Francisco, and a smaller portion to southern California.

The problem of transportation is undoubtedly the most vexatious with which the Pacific coast lumberman has to deal. A decrease in the cost of transportation opens new markets, and increases profit in old markets.

The past decade has been marked by a constant evolution in the methods of harvesting and manufacturing lumber. Where the ox-team laboriously drew to tidewater a turn of logs a few years ago, the steam donkey now performs the same task cheaper and more conveniently. As the timber was cut away from tidewater, cattle became useless, and to-day the wire cable penetrates into the woods for a distance of six thousand feet from the camps, hauling the great firs over stumps and up steep grades as easily as the ox team could haul them on a down grade, and more expeditiously. As the camps have penetrated further into the woods, railroads have followed in their wake. There are now operating in Washington logging railroads hauling thirty-three miles to tidewater, while the trans-continental lines have added to their business by hauling logs from the western slopes of the Cascades to the mills of Puget sound.

The occurrence of fires among the mills has kept the majority of them up to date. Where immense logs have to be handled, the best and most complete appliances must be used. The circular saw is gradually giving way to the lumber-saving band saw. With the revival of the lumber trade every mill is increasing its capacity. This is accomplished by the addition of improved machinery. Dry kilns and planing mills are being added to nearly every plant, so that the market of the eastern States can be entered.

The Pacific coast forests are not "inexhaustible,"—far from it,—but, with proper use and care, they should be equal to the future needs of home and foreign consumption. The forests now standing are mature, and are not bettered by not being cut. At least 90 per cent. of the cut-over lands are of absolutely no value for agricultural purposes. They are adapted only to timber growing. Moreover, the native species, if protected from fire, are, as a rule, readily and quickly reproduced. Let land-owners and loggers recognize these facts, and treat their cut over lands as growers of another timber crop. Let a wise policy protect the forests and cut-over lands from fire, and further the work of reforestation. The lumber industry is legitimate and necessary business, despite certain sentimentalists; moreover, if properly managed, its future has more in store for the Pacific coast than all that her gold fields have yielded.

THE MINING, SMELTING, AND REFINING OF NICKEL.

By Titus Ulke.

AT the Canadian Copper Company's refinery at Sudbury the matte, after remelting in cupolas, is sometimes run into bessemer converters, similar to those used in the refining of copper. There are three converters in the refinery, one being in use, while a second is being relined and a third is kept in readiness for a charge, when the bessemer plant is in operation. The capacity of the latter is about twenty-five tons of cupola matte supplied, or fifteen tons of bessemer matte produced in twenty-four hours. In the converters the iron is almost entirely removed, the sulphur is lowered to about 14 per cent., and the copper and nickel are raised to about 43 per cent. and 40 per cent. respectively. As there are none of the usual flame reactions to guide the operation, the point at which to stop the blowing, after the iron has been removed and before the nickel has commenced to slag in undue amounts, is a matter in which the skill of the furnace manager is best shown. As the converter slags rarely show more than 2 per cent. of copper and 3.5 per cent. of nickel, and as the ratio of copper to nickel in the supply is nearly the same as in the product, sufficient proof is given of the skill and judgment needed and practiced in the bessemer concentration of a metal so easily oxidizable as nickel. All converter slags are returned to cupolas for remelting.

For convenience in handling, the converter matte is cast in slabs three feet square and about three inches thick, weighing about fifteen hundred pounds each. These slabs are lifted to the cars by hydraulic cranes, which serve for handling the converters. An average analysis of Canadian bessemer matte is: copper, 43.36 per cent.; nickel, 39.96 per cent.; iron, 0.60 per cent.; sulphur, 13.76 per cent.; silver, 7 ounces per ton; gold, 0.1 to 0.2 ounce per ton; platinum, 0.3 ounce per ton; palladium, 0.2 ounce per ton. This matte is produced only in very limited quantities, compared with ordinary matte, as the latter is in much greater demand.

In Europe much of the low-grade nickel matte is refined by bessemerizing, as the latter operation requires much less time than the reverberatory, or English, method of refining, to be described later.

At Havre molten Caledonian matte is run into one-ton converters, and is blown with a pressure of about forty centimetres of mercury.

The temperature rises, and a quartzose mixture is thrown on the surface to scorify the iron. If the matte does not contain more than 36 per cent. of iron, the latter can be removed in about one hour and twenty minutes. If there is more than this, the bath should be skimmed at least once after the first twenty-five minutes, and another portion of the flux added.

After the final skimming, and when the nickel is found to be oxidizing in its turn, the refined matte, containing but 0.5 per cent. of iron, 75 per cent. of nickel (including a little cobalt), and 24 per per cent. of sulphur, is run off. Nearly all of the arsenic, antimony, and silver are carried off by the blast, or enter into the slag. This slag contains 14 per cent. or 15 per cent. of nickel, mostly in the form of prills carried into the pasty mass by the blast. Part of this can be recovered by running the slag into settling-pots and allowing the metal to sink to the bottom. The slag, however, is generally returned to the blast furnace for remelting.

It seems natural to continue the action of the blast in the converter upon the matte freed from iron, in order to burn out the sulphur, and so obtain refined nickel, which would then need only to be heated in a reducing atmosphere to reduce whatever oxide may have formed, as is done with copper. Numerous attempts in this direction have been made, but it appears impossible to succeed with nickel in this way. After the iron has been removed, not only does the nickel oxidize with the sulphur, but the temperature falls, because the combustion of the sulphur, which is lessened by the latter's affinity for nickel, does not compensate for the cooling due to the injection of the air. The bath, therefore, tends to solidify, and this effect is the more speedy as the uncombined nickel produced can remain in the liquid state only at a very high temperature—near that of molten iron.

Bessemer matte, containing 800 pounds of nickel and 800 pounds of copper to the ton, was recently quoted at $125 to $180 per ton at Sudbury, the price largely depending on the quantity purchased.

The cost of bessemerizing the ordinary matte is said to be only $12 to $15 per ton.

6. The Orford Process, or Separation-Smelting. The prime object of this operation is the separation of the copper from the nickel in the Canadian matte. For this purpose the ordinary matte is subjected to preliminary treatment by calcining and then melting in a blast furnace, so that the metals are finally present substantially as subsulphides. With bessemer matte this preliminary treatment is, of course, unnecessary.

At the Orford works, which handle by far the greater part of the Canadian output, the matte is now charged with the proper proportion of salt cake and coke into a water-jacketed Herreshoff furnace, whose contents, after melting, are passed into settling pots. In the furnace the salt cake, or sodium sulphate, is reduced to sodium sulphide, which unites with part of the iron and copper to make a very fluid mass, from which the sub-sulphide of nickel separates by gravity. On cooling, therefore, the bulk of the nickel settles to the bottom of the pot, and is separated by hand from the "tops," which contain the bulk of the copper, iron, and soda. The tops are exposed to the weather, whereby the sulphide is converted into sodium sulphate and carbonate, or into so called caustic soda. Then these tops are mixed with a little matte and sufficient coke, and remelted in a second blast furnace, whereby the "caustic" soda is converted into sulphide of soda at the expense of the nickel, leaving the latter in a semi metallic state, so that again a top and a bottom are formed, with copper and iron in the top and nickel in the bottom. By a similar treatment of the "bottoms" a relatively pure sulphide of nickel is finally obtained. As the latter still contains copper, besides more than half of the platinum and palladium in the original matte, it is roasted with salt in a reverberatory furnace and heated to a temperature which will enable as much nickel oxide as possible to form, together with chloride and sulphate of copper, silver, and palladium. The roasted mass is then leached, to separate the more insoluble nickel oxide from the chloride and sulphate solution. Finally, the leached nickel oxide is sold as such, or is reduced, by smelting with coke, to crude nickel, which is cast into anodes for electrolytic refining.

7. Reverberatory-Refining (English Method). In France and Germany low-grade nickel matte is often refined in reverberatory furnaces.

The reverberatory refining, according to D. Levat, requires two operations, each of which includes two phases,—*viz.*, roasting, and fusion with quartzose sand, in order to scorify the iron. Two tons are treated per furnace in twenty-four hours, with a consumption of two tons of coal. Samples are taken in the course of each operation (which lasts about eight hours), in order to arrest the work as soon as the iron has disappeared, thus preventing the passage of the nickel into the slag. The latter is seldom discarded before retreatment, for it often contains fully two to two and one-half per cent. of nickel, and makes an excellent flux.

The first operation in the reverbertory produces a matte with 2.5 to 3 per cent. of iron, the second a matte containing not more than 0.5 to 0.75 per cent of iron. The refined matte should not contain less than 16 per cent. of sulphur, so that it may be easily pulverized for subsequent treatment. The composition of the matte freed from iron is generally as follows: nickel or cobalt, 75 per cent.; sulphur, 24 per cent.; iron, 0.5 per cent.; other impurities, 0.5 per cent. The total impurities should not exceed one per cent., for the subsequent operations remove only the sulphur. For this purpose the matte is crushed to 65 mesh, and is roasted in a large furnace (33 feet long by 8 feet wide), with four doors on a side, to enable the workmen to rabble the charge along toward the fire-bridge. The charge is about 1,400 pounds, and the operation lasts six to eight hours. In twenty-four hours about one and one-half tons are roasted and one ton of coal is consumed. The temperature is kept at a dark-red heat, to prevent fusion and produce an oxide with only a small proportion (about 1 per cent.) of sulphur and sulphates. This material, after being crushed to 120 mesh, is then subjected to another roasting, during which the temperature is raised to a bright red. The resulting oxide (or oxides, for copper oxide from a cupriferous matte is not eliminated) should not now contain more than 0.4 per cent. of sulphur. It is reduced in either loose condition, or after having been formed into cubes, with charcoal in crucibles, or subjected to a direct reduction-melting, the metal being refined with a little magnesium, and cast into cakes, or shotted.

It is estimated that the total cost of reverberatory refining and the production of metallic nickel from one ton of matte slightly exceeds $20.

8. The Wet Process of Refining. The wet process of refining is used in Europe on ores, speiss, matte, and richer nickel products containing copper, when absolutely pure nickel is desired.

The above raw material is pulverized and calcined, if necessary, and is then leached with hydrochloric acid, aided by steam. A chloride solution of the soluble metals is thus obtained, which is siphoned off from the waste gangue and ferric oxide. To remove the balance of the iron and the arsenic, the solution is treated with both chloride and milk of lime, together with steam, whereby any arsenic and ferrous iron present are peroxidized and precipitated. The copper contained in the solution drawn off from the ferric hydrate and iron arsenate precipitate is now thrown down in the acidified heated solution, by means of sulphuretted hydrogen, and the resulting copper-sulphide, available for the production of copper, is filtered off. Should the filtrate, a solution of nickel chloride, contain cobalt, the excess of the hydrogen sulphide must be boiled off, the excess of acid neutralized with milk of lime, and the cobalt peroxidized and precipitated with steam and chloride of lime. The products thus obtained are cobalt oxide which goes into the market, and a solution of nickel chloride.

For the production of metallic nickel from the chloride solution nickel hydrate is precipitated by means of milk of lime. The dried hydrate is then made into a paste with flour, and baked. The baked mass, broken into fragments and strongly heated, parts with its carbon and gases, and leaves metallic "grain nickel," which is sold.

9. Electrolytic Refining. Orford anodes, containing 95 to 96 per cent. of nickel, 0.2 to 0.8 per cent. of copper, 0.75 per cent. of iron, 0.25 per cent. of silicon, 0.45 per cent. of carbon, 3 per cent. of sulphur, and 0.5 ounce of platinum per ton, are electrolytically refined at the Balbach Works, Newark, New Jersey, for the Orford Copper Company.

There is reason to believe that a neutral or slightly ammoniacal sulphate bath is employed in this process. According to Dr. Foerster the electrolyte probably contains about 480 grams of commercial nickel sulphate—*i. e.*, 100 grams of nickel—per liter, and is heated to a temperature of 50° to 90°C. Good, coherent deposits, bright grey or tin white in color, may then be obtained by using a current density of from five to twenty-five amperes per square foot of cathode surface. Other metallurgists, whose view the writer shares, do not believe that hot solutions are employed. In any case refined nickel is actually produced, containing from 99 to 99.6 per cent. of nickel, 0.12 to 0.14 per cent. of cobalt, 0.1 to 0.2 per cent. of copper, 0.1 to 0.4 per cent. of iron, 0.03 per cent. of arsenic, 0.02 per cent. each of manganese, sulphur, and silicon, and traces of platinum. The anode scrap and slime are partly treated to recover platinum, and are partly remelted into nickel anodes.

In the electrolytic refining of the crude nickel, certain precautions must be taken. It is, of course, necessary to guard against the accumulation of copper, arsenic, and iron in the bath; otherwise, serious injury to the deposited nickel may result. In a neutral sulphate bath, however, it is easy to eliminate the copper, if this metal is present only in small quantities, as the nickel of the anode precipitates it to a large extent immediately. Iron is the greatest obstacle, as it is apt to deposit with the nickel; anodes rich in iron should, therefore, be avoided, if nickel free from iron be desired.

In electrolytic nickel-refining a large quantity of anode scrap is invariably produced. This is unfortunately the case even with anodes averaging as high as 90 per cent. of nickel, owing to their uneven solution and consequent disintegration.

The usual difficulty in depositing a thick plate of pure nickel, due to its tendency to peel off, is overcome, it seems, when a heated neutral nickel-sulphate solution is employed. Under proper conditions, however, thick deposits may easily be obtained even with cold solutions.

At any rate, the Balbachs have succeeded in electro-depositing nickel plates 20 by 30 inches in size and 3/8 to 1/2 of an inch thick, which are so tough and elastic that it is very difficult to chisel the metal; and the shearing of plates more than 1 mm. in thickness is as troublesome as the manipulation of so much tempered steel. For this reason, and because of the difficulty of handling heavy cathodes, the Balbach Co., in refining for the Canadian Copper Co., take out the cathodes when they are about 1/2 of an inch thick. It is an important fact, also, that these plates, ordinarily, will neither break under the hammer or crack under the punch. Nearly three tons of this metallic nickel are now produced daily in Newark by the Balbach Smelting and Refining Company, and a small quantity by the German firm of G. Menne at Siegen. The greater portion of the output of pure nickel is used in making nickel steel and German silver, the balance being cast into anodes for nickel-platers.

The value of the platinum and palladium contained in the Canadian ore annually mined is more than $30,000. A part of this the electrolytic process saves, and it will soon be placed on the market.

The value of the world's product of metallic nickel and nickel oxide in 1897 exceeded, it is said, $1,300,000.

A MONTH OF ENGINEERING PROGRESS

A GENERAL view of engineering progress as indicated in the references in THE ENGINEERING INDEX this month shows several noteworthy features, some of which, as might be supposed, bear a close relation to recent political developments. The relation of the engineer to the statesman and to the development of such enterprises as the Siberian railway, the Nicaragua canal, and the Pacific cable frequently forces the hand of the politician and compels him to admit that the pen which is mightier than the sword may sometimes be the drawing pen of the engineer.

Not only is Nicaragua being discussed, but Panama is showing symptoms of revival, and although popular opinion is undoubtedly strongly in favor of piercing the isthmus at some point, the contest between the rival routes is by no means yet settled.

The acquisition of the Hawaiian islands by the United States has awakened the subject of a Pacific cable, which, if not all British, may at least be all Anglo-Saxon, and provide a solution of the political and commercial problem of communication between all parts of the British empire, freed from the possibility of interruption in case of a general European war.

As the work of the engineer often precedes political changes, so political and military upheavals create new demands upon the engineer. Papers upon battleship design, armor, and gunnery are the natural product of the experiences of the Spanish-American war, while the questions brought up by the experience on both sides with torpedo boats and destroyers have led to a re-opening of the entire subject of the construction and proper use of these highly-specialized fighting machines.

The political agitation and possible changes in the policy of the Chinese Empire have created much interest in the commercial world, and the engineering opportunities which would inevitably follow the opening or disintegration of China, are already being considered from various standpoints.

While England has been aroused to the fact that the admirable methods of technical instruction in Germany have had much to do with the rapid development of competition in engineering matters, the Germans are discussing the overcrowded condition of their technical schools, and endeavoring to transfer the ground-work of scientific education to the lower schools and, by stringent examinations and other restrictions, keep down the attendance of students in the higher schools to a more manageable number.

The interest in the Paris exposition of 1900 increases as the work progresses, and the plans for power generation and distribution, as well as the lighting of the Champ de Mars which are now made public, show the influence which the development of the modern power-house has had upon the engineers of the Exposition. Instead of a miscellaneous collection of engines and boilers arranged with entire disregard of each other, the visitors will see two well ordered power-houses, containing standard steam and electrical units, representing the latest practice of all industrial countries. The great arch of the Alexander III bridge will now also make rapid progress, since the false works across the Seine are ready for the reception of the superstructure.

The utilization of natural sources of power goes actively forward on both sides of the Atlantic, and accounts come from Switzerland and Sweden, from New York and Colorado, of the installation of hydraulic and electric power generating stations, while attention has been forcibly called to the vast amount of hydraulic power awaiting development in Italy.

Ever since the announcement last summer of the success of the Diesel motor, attention has been directed to the improvement of internal-combustion motors, and the later applications of blast-furnace gases to the direct production of power in gas engines has formed the subject of articles nearly every month. The thermodynamics of the gas engines has received renewed attention, and these points all form subjects of papers in the recent technical press.

In municipal engineering the interest in bacterial processes of sewage purification continues, having formed the subject of an important paper before the British Association, and the method is being extended to new installations. The question of the prevention of smoke in cities is also receiving attention, and the example of Paris in enforcing reasonable smoke-prevention ordinances is likely to be followed by other large cities.

Automobile vehicles receive due share of notice in the technical press, the report of the Birmingham trials being made public in England, while the automobile-cab system of New York city has been extended by the addition of a number of new and improved vehicles.

Although the introduction of acetylene as an illuminating agent has progressed but slowly, new plants for the production of calcium carbide are being constructed both in Europe and America. It is a matter of some curiosity as to the disposal of the product of these works, for with the exception of the use of mixed acetylene and oil gas for the lighting of railway carriages in Germany, there seems to be an outlet for the carbide only in isolated and experimental plants.

The development of electric traction continues to be an important industrial and constructive matter, although nearly all the articles are simply descriptive of new installations, or deal with details of individual plants. The opening of the first three-phase electric tramway in France, at Evian-les-Bains, is made a subject of note in the continental press, and constructive features of overhead and underground conductors for electric roads are discussed.

In general railway work the controversy over the speed of trains seems to have been pretty well thrashed out, although some communications upon this well-worn subject still appear in the English press. In the United States the decision of the supreme court in the joint traffic association case is the subject of various editorials, it seeming to be the general opinion that while the decision is doubtless technically correct the practical results will not be to the benefit either of the public or the railways.

Internal waterways receive notice, especially in connection with existing and projected works on the continent, and comparative studies of land and water transport, as well as the improvement of river navigation, form the subjects of various papers.

An important paper upon the subject of the so-called fatigue of metals deserves attention in view of the severe service which many bridges and viaducts are called upon to endure, especially in the vicinity of great terminals, or in connection with local transportation in large cities.

In manufacturing establishments the questions involved in the management of labor and the best methods of shop accounting form features of constant discussion, and the important question of cost-keeping is expounded and discussed in several papers.

In the wide domain of mining and metallurgy the most notable contributions are those bearing on the successful working of gold by the cyanide process, including the electro-deposition method. There are also contributions to the development of the production of iron and steel, and the interest which has been developed of late in the safer use of mining explosives and in the prevention of disaster from firedamp is sustained in several important articles.

The whole work of the month, as recorded in detail in THE ENGINEERING INDEX, on pages 483 to 519 of this issue, shows a continuance of that increasing industrial activity which has been such a marked feature of the year, and which promises to extend into the coming year.

REVIEW OF THE ENGINEERING PRESS

Engineering in the United States Navy.

THE reports of the engineer-in-chief of the United States navy are always interesting reading, but that for the present year is especially valuable, coming as it does fresh upon the active service of the navy in the Spanish war. So many excellent points are made that to discuss them all here would involve reprinting nearly all of the original document, but the leading features at least will be noted.

One of the most important portions of the work of the bureau was that of completing repairs, equipping auxiliary vessels, and similar emergency work. This naturally brought out the deficiencies of the various navy yards, and must lead to improved equipment, use of modern tools, and general introduction of facilities for such emergencies.

In regard to the behaviour of machinery during action, most satisfactory results are reported for the vessels of the fighting squadrons:

"Even in action, when forced-draft conditions were in operation and the excitable natures of the men most wrought upon by the surroundings, the reports show that the machinery not only worked well generally, but that in no case was it greatly distressed. This is as fine a commentary upon the personnel as on the machinery.

"It is greatly to be regretted that the torpedo boats cannot show the same excellent records for their machinery, but it is a sad fact that nearly every one has had some accidents, and the machinery of some at the close of the war was in a condition which can only be described as horrible, where boilers were burnt, cylinder covers broken, pistons and valves stuck, and everything in bad shape. This condition of affairs seems attributable to two causes,—the absence of trained engineering supervision, and the use of the boats for duty to which they were not adapted."

The first of these causes arose out of the mistake of placing the highly organized pieces of machinery under the care of line officers, without engineering training and naturally unfit for such specialized duty. As to the second cause the improper use of the boats,—it should not have required experience to prove that this type of vessel can not be safely used for dispatch-boat duty and to act as tender to blockading ships far from base of supplies or facilities for efficient repair. Primarily, it is intended for high-speed spurts, where success or failure in the use of its special weapon will be quickly demonstrated. For this it is especially built, and for this it should be solely kept.

Among the noteworthy engineering features of the war may be noted the equipment and successful use of a floating machine shop as an integral portion of a fleet. The Vulcan, which was set aside for this purpose immediately on prospect of war, has proved a most successful experiment, and it is recommended that a similar vessel be fitted at once for service in the Pacific. Between July 1 and August 31 the Vulcan made repairs to 63 ships and supplied stores to 60.

Her unusual facilities and the large number of skilled mechanics on board (about 100) enabled her to make repairs of all kinds, including hull work, gun mounts, dynamos, main steam pipes, main piston rods (for small ships), brass castings without end, and iron castings in considerable quantity. This last is specially interesting as the first instance of the successful use of a cupola on shipboard.

The importance of distilling ships is emphasized, being important for cylindrical boilers, and absolutely necessary for water-tube boilers, and, although the two ships under equipment for this purpose were not ready before the close of hostilities, they have been successfully completed since.

In view of the discussion in England, it is interesting to note the unqualified manner in which the use of water-tube boilers is endorsed in the report. In all the recent designs; except those of battleships, this type of boiler was specified, and it is now practically certain that water-tube boilers will be used in these also.

"The demands upon the engineer for great power on small weight, in order to secure the higher speeds for all classes of vessels which are now common, have practically ruled out the cylindrical boiler, on account of its weight and inability to carry the high pressures needed.

"The tactical importance of water-tube boilers is also being thoroughly recognized, and has been emphasized by the conditions which obtained in our blockade of Santiago and the great victory of July 3. It was necessary for a long period that our ships should be ready to develop maximum power at a few minutes' notice, and with cylindrical boilers this involved keeping all the boilers under steam, with heavily-banked fires and an attendant large consumption of coal. Water-tube boilers of the proper kind, which admit of the rapid raising of steam with safety, remove this difficulty, and give the commanding officer a more complete control of his fighting machine."

In closing, the engineer-in-chief gives his opinion as to the lessons of the war in connection with that portion of the work which came under his immediate department, and these are so important that we give them here in his own words:

"The war which has just ended is the first in which modern steam vessels have had a thorough trial, and it seems pertinent to note the more important lessons which have been taught by our experience. With respect to the machinery they are as follows:

"1. The vital necessity of giving the machinery of vessels in reserve frequent tests under working conditions, so that any defects may be discovered and remedied before war makes the vessels' services absolutely necessary. In several cases defects were found after the ships had begun cruising, and the repairs laid them up in the midst of the war.

"2. The great importance of having all our naval stations in positions of strategic value properly fitted out for repairs and with adequate supplies of non-perishable stores. It had been evident for a long time that Key West was such a station, but money to put in a proper repair-plant was refused year after year, and only granted after the war had begun. The movement of large bodies of troops and their equipment almost blocked the railroads, so that after the beginning of the war it was almost impossible to secure the forwarding of tools and supplies.

"3. That fresh water for the boilers is almost as important as coal, and that a distilling ship is an important adjunct of a fleet operating away from a base where fresh water can be readily obtained.

"4. That every fleet needs a repair ship to enable the efficiency to be maintained without leaving the station, and consequently that several ships should be equipped so as to be ready to proceed with the fleet.

"5. The great tactical advantages of water-tube boilers. This has already been discussed under another head.

"6. That, if more than two main engines are to be fitted, there should be three engines driving three screws, and not two main engines on each shaft. The New York and Brooklyn had their forward engines disconnected at the time of the Santiago fight, and could not stop to couple them. An accident to any part of either of the two engines on a shaft disables half the power; in the three-screw ship this fraction would be only a third.

"7. That there should be frequent trials under forced draft to keep the blowers in good condition and to make the men thoroughly familiar with working under maximum conditions. It appears that some of the ships had never been under forced draft since their contract trials until the day of the fight at Santiago.

"8. That the location of the forced draft blowers is a matter of serious importance. In some of our ships, owing to the demands for all other space for other purposes, the blowers had to be located in corners or pockets in the fire rooms, where it was impossible for human beings to give them proper attention, owing to the intense heat due to lack of ventilation. In the Cincinnati temperatures as high as 205° Fahrenheit were noted, and the commanding officer, when investigating the case personally, had his face scorched. The blowers must be placed where they can be properly cared for, or else they are useless, and might as well be left on shore.

"9. That the personnel of the service should be adequate to the materiel. It has been notorious for some time that this is not the case, and we are providing for a decided increase in the number of vessels with no increase whatever in the personnel. By sending nearly every officer on the active list to sea we were able to give the regular ships a fair complement of trained ones, but, had the war been of long duration, we should have been greatly embarrassed to supply the places of those disabled or invalided. Volunteers, however well trained in other ways, cannot entirely replace the regular officer.

"10. That we must make provision for training the enlisted men of the engineer department. Many of the colliers and auxiliary vessels had to start out with absolutely green crews, many of whom, so far from having the 'sea habit,' had never been on a vessel of any kind. This must be remedied, if our enlarged fleet is to be efficient.

"11. That our fighting ships must have the highest practicable speed. There is an almost general agreement on this point among naval men, but, if any had thought that this did not apply to battleships, the fight at Santiago must have shown that the highest practicable speed is just as important in these vessels. It is very gratifying, therefore, that our three new battleships are to have speeds of at least 18 knots, which is now recognized as the standard."

The Melting-Point of Cast Iron.

In a paper recently read before the Pittsburg Foundrymen's Association, and published in the *Iron Age*, Dr. R. Moldenke discusses the conditions which determine the melting point of cast iron, and also describes an ingenious modification of the Le Chatelier pyrometer, which enables it to be used to measure the temperature of molten metal in the ladle.

The pyrometer, as usually made, contains a thermo-electric couple formed of two wires, one of pure platinum and the other of an alloy of platinum with 10 per cent. of rhodium, these being enclosed in a porcelain tube to be inserted through the walls of a furnace and exposed to the action of flame or hot gases.

The instrument, as modified by Dr. Moldenke, is made with an iron tube for a portion of the length of the wires, this being bent 90 degrees and carrying at the end a clay tip containing the fused connection of the wires. This tip can be plunged into the molten metal and the correct temperature obtained almost immediately, while the construction is such that the clay tip can be readily replaced when necessary.

Although only a limited number of investigations have been made with this apparatus, Dr. Moldenke gives the tabulated results thus far obtained with pig irons, cast irons, steel, and some alloys and softeners, together with the chemical compositions.

The irons are arranged in the tables according to their combined carbon contents, and it is evident that, with few exceptions, the melting-points increase as the combined carbon goes down, this being the case independent of the amount of graphite present, the temperatures ranging from 2,030°F. for 3.98 per cent. of carbon, to 2,280°F. for 0.13 per cent. Alloys have a lower melting-point than that of any of their constituents; so also a white iron, really an alloy of carbon or some carbides of iron with iron, should melt sooner than the purer iron in the gray variety.

The tables show the melting-point of steel, for the specimens given, to be 2,450° and 2,350°F., and the fact that steel has a higher melting-point than that of the grayest irons shows that there are other considerations which affect this.

The difference in the melting-points of steel and gray iron may be due to the solution of the graphite in the iron before the actual melting takes place, but this is offered only as a supposition; possibly further researches will throw further light upon the subject.

These investigations, it is hoped, are but the beginning of a more extended series, and, in view of the readiness with which the modification of the pyrometer makes it possible to do such work, the melting-points of many metals may be accurately determined.

Proportioning Cone Pulleys.

THE difficult nature of the problem of proportioning a pair of cone pulleys so that the length of the belt shall remain constant for any required set of speed-changes has caused numerous attempts to devise practical working methods for general use. Among these one of the very best is that given by Professor Reuleaux, in which Mr. Walter K. Palmer has made notable improvements, and in a recent issue of the *American Machinist*, Prof. Sweet discusses the whole subject, in the light of these latest methods and of those used by him many years before.

Cone pulleys are very generally used on lathes, in connection with a set of back-gears, so that, with four steps on the cone, for example, eight changes of speed are obtained; but with many lathes of older design these speeds are found to form a series with unequal intervals between the various members, a very irregular curve being formed when the speeds are plotted graphically.

This is especially the case in the change from the slowest speed with back-gear out to the fastest with back-gear in, there frequently being what is termed a "lump" in the speeds at this point. This is sometimes due to the use of a pair of cones designed for some other purpose, or to the use of an existing pattern with one step left off or an extra step added; and in any case this feature should be taken into account in designing a speed-change system involving cone pulleys and back gearing.

Professor Sweet has added to the work of Reuleaux and Palmer in a very practical way by showing how a curve may be plotted for any pair of cones which it may be desired to use, and how from this curve may be determined the back gear reduction which will give a regular gradation of speeds. Instead of selecting a ratio of back gear and endeavoring to design a pair of cones to suit, the ratio of speed-increase is first decided, from which the ratio of the back-gear can be found, and the system proportioned as a whole.

While the problem, considered as an example in applied geometry, is most interesting, and, as an exact solution, is in some cases very desirable, yet, as Professor Sweet points out, the practical limitations of the materials and data usually prevent a very precise determination.

One of the fundamental data required is that of the distance between the two cone pulleys, while in fact the pulleys must be made for machines which are to be used in various locations, and the distance between cones depends upon the height of ceiling or other local conditions, so that only an approximate degree of accuracy in proportions can be obtained for machines to be sold in the ordinary course of trade. When it is remembered, however, that a leather belt is so elastic a factor in the cone-pulley problem that a variation of one-tenth of an inch in the diameter of the pulley is of little consequence, it will be seen that the error due to a moderate variation in the distance between shafts is immaterial.

Professor Sweet's paper forms a very satisfactory supplement to Mr. Palmer's pamphlet, and is at the same time a desirable contribution to the history of the subject.

The Fatigue of Metals.

EVER since the experiments of Wöhler the subject of the so-called "fatigue" of metals has been discussed from various standpoints, and, although most engineers have acknowledged the deterioration indicated by those experiments, some prominent experts have denied such action. Thus, for example, no less an authority than Mr. Theodore Cooper maintained that the term "fatigue of metals" was "absurd and unscientific, and totally at variance with the acceptance of the perfect elasticity of metals as heretofore accepted."

At the same time many others, of equally high reputation, accepted the theory of Wöhler, and have used the formula deduced from his experiments by Launhardt in proportioning framed structures.

One of the stanchest advocates of the theory of Wöhler is Mr. Henry B. Seaman, and, in a paper recently presented by him before the American Society of Civil Engineers on the Launhardt formula, he not only re-discusses the original experiments, but adds to them the results obtained by Bauschinger, deducing some additional relations which confirm the theory very fully.

Wöhler's experiments, made in 1870, showed that a repetition of stresses below the ultimate strength of the material finally causes rupture, from which it follows that a lower working stress should be allowed when the live load is a large proportion of the total load than that allowed when the dead load preponderates.

In the Launhardt formula the working unit stress may be determined for any given relation of live and dead load, and since 1882 the formula has been extensively used in America.

The most important result deduced by Mr. Seaman from his re-examination of the experiments is the fact that the effect of a live load applied repeatedly is equal to a dead load twice as great.

" Although the results are derived from experiments with different kinds of strain, and are too brief to permit the formulation of any definite theory, there seems to be ample basis for a general theory of work,—*i. e.*, that the material is capable of doing a certain amount of work (derived possibly from treatment, or work, which it receives in manufacture), and, when that amount of work is exceeded, the material becomes fatigued, and its tenacity finally destroyed. Under these circumstances the destructive effect of live strain may be considered as bearing a certain relation to that of dead strain, and in the experiments on wrought iron that effect would seem to be about in the ratio of 2 to 1 for all cases."

This fact makes the computation for the same load a very simple matter, and renders the application of Launhardt's formula unnecessary. All that is required is to double the live load and add it to the dead load, and, considering the result as all dead load, proportion the members accordingly.

It must be understood that this makes no allowance for the effect of impact and for the increase of compressive strains due to flexure of columns. For these Mr. Seaman recommends the column formula in general use, taking an allowable dead unit strain of 18,000 pounds. For alternate strains, however, the increase of compressive strain on the outer fibre due to flexure of column is found first, and then the compressive strain thus increased is added to the tensile strain, in order to find the total live strain.

In some instance it may appear that the dimensions deduced according to Mr. Seaman's method are unnecessarily great, but, when the conditions of many structures are carefully examined, the importance of providing for the actual working strains becomes evident.

" In outlining general specifications, provision must be made for extreme conditions. In the elevated railways of large cities, or in the large railway terminals, where the passage of trains is almost incessant. there is little rest for the structure; while the vibrations of all rapidly-passing loads, together with unbalanced drivers, flat car-wheels, and defective track, will increase the live strains very considerably in addition to the impact due to sudden application. When it is also remembered that, according to Bauschinger, it takes days, and perhaps weeks, for the material to recover fully from an applied strain, the ratio of 2 to 1 for dead and live strains does not seem to be excessively great."

The general acceptance of the truth of the condition of fatigue in metals renders Mr. Seaman's paper very acceptable at the present time, and the specifications for steel railroad bridges which form the appendix to the paper add to its value for the working engineer.

The Panama Canal.

THE interest which has been awakened in an isthmian canal is not confined to the Nicaragua project, and many still believe that Panama is the best point at which to construct the waterway between the two oceans. Much of the distrust which still attaches to the name Panama is due to the mismanagement and jobbery which proved the downfall of the original scheme, but since that collapse there has been a thorough investigation of the real merits of the project by a competent board of experts, and from the pen of a member of this commission, General Henry L. Abbot, there appears an excellent paper on the present status of the Panama Canal, published in *Engineering News :*

" The original plan contemplated placing the canal in the bed of the Chagres, and conducting the river to the sea through artificial channels. This project was long ago definitely abandoned, being replaced by the familiar system of locks and dams which has been so often successfully applied to other rivers. Careful measurements and studies of the regimen of this torrential stream have shown the system to be entirely applicable to it, and that none of the constructions demanded will exceed the limits of recognized engineering practice. To these advantages it should be added that two good harbors already exist at the Atlantic and Pacific terminals ; that an American railway is in active operation, parallel and in close proximity to the line of the canal throughout its entire extent ; that about 40 per cent. of the whole length has been actually excavated, and that great progress has been made on the intermediate portions ; and, finally, that extensive preparations have already been made for accommodating the army of laborers which will be required on any isthmian canal. These reasons certainly demand that the comparative merits of this route should be considered before adopting any other location for the canal now generally believed to be essential to meet the needs of our Atlantic and Pacific coasts."

In comparing the relative merits of the Nicaragua and Panama projects, General Abbot gives maps and profiles of the two routes, showing that the Panama route is only one-fourth as long as the proposed Nicaragua Canal, while the constructive difficulties presented by the Nicaragua project are fully as great as those presented by the Panama project, and the bottom of the summit level is about twelve feet higher above datum in the Nicaragua profile than in the Panama.

One of the special obstacles supposed to exist in connection with the Panama scheme has been the regulation of the Chagres river, which, with its tendency to floods, has been supposed to offer especial difficulties. This matter has received careful attention from the Comité Technique, and the details of flow and the character of dams and overflow weirs proposed are described at length.

It is the opinion of the commission that the hydraulic problems presented by this turbulent river—at one time regarded as so serious—admit of satisfactory solution. This is hardly the case in Nicaragua, where one of the great difficulties of project is the regulation of a summit level depending on that of an immense lake 2,700 square miles in extent, receiving directly the drainage of 8,700 square miles of territory, together with that of 2,250 square miles more through the tributaries of the San Juan river above the dam at Ochoa,—conditions which render the ordinary method of storage reservoirs wholly inapplicable. Nevertheless, a delicate regulation of this level, and at an artificial height, is essential to avoid, on the one hand, drowning a cultivated district on the west shore, and, on the other hand, exposing rocks in the navigable bed of the San Juan. These difficulties are aggravated by the necessity of placing the overflow weirs near Ochoa, at a distance of more than 100 kilometres (62 miles) from the lake.

According to General Abbot, the careful estimate of the cost of completing the works at Panama, is, in round numbers, one hundred million dollars, and the time required is put at ten years. This is within the lowest of the Nicaragua estimates, and there appears to be no advantage in economy in favor of the latter.

What Panama apparently needs is a complete assurance that none of the jobbery and blackmail of the old scheme shall adhere to it, and that the engineering problems be dealt with on a scale commensurate with their importance, the work being placed in honest and competent hands.

The Reconstruction of the Victoria Bridge.

A VERY interesting piece of engineering work, both from a professional and a historical point of view, is the reconstruction of the famous Victoria tubular bridge across the St. Lawrence at Montreal, and from an account given in the *Engineering Record* some particulars are abstracted.

The Victoria bridge, begun in 1852, and opened in 1859, has long been considered one of the engineering wonders of the world, not so much because of its particular novelty of construction,—for it was similar to the original tubular bridge at Menai strait,—as because it was the first great railway bridge built in America, was the longest and most costly bridge of its time, was designed by Robert Stephenson, and was opened by the Prince of Wales.

The most difficult portion of the work was that of the pier construction, the river being 22 feet deep, with an average current of 7 miles an hour, and the piers rising 40 feet above the surface of the water. These piers, somewhat widened, are retained, but the old tubular superstructure is replaced by pin-connected steel trusses, furnishing room for double railway track, two carriage roadways, and two footwalks. It is interesting to note that the new bridge has almost exactly double the weight of the old structure, while possessing five times the live-load capacity.

The papers in the *Engineering Record* contain much interesting information about the construction of the old bridge, taken from the somewhat inaccessible volumes published as a memorial at the time of the formal opening of the structure, but the matter of present interest is rather the manner of erecting the new trusses without interrupting travel through the old tubular spans.

This was accomplished by placing steel beams across the tops of the piers, projecting a short distance on each side. The end floor beams of each span were riveted with web connections to the ends of these beams, forming a box enclosing the top of the pier. Two trusses were then run out from the shore pier by the aid of a false-work span to make the first span, and an overhead traveller was constructed upon this, so that the trusses for the second span could in turn be erected and run forward.

The work thus progressed for successive spans, care being taken to impose no permanent load upon the old tube. Traffic was unobstructed, except for intervals of an hour or two, when the false work span and traveler were being moved. This method was duplicated from the other end of the bridge, a force of two hundred and fifty men succeeding in assembling and swinging nine 254-foot spans in one month.

The new bridge is now practically completed, and the old tube is being removed, so that the once famous Victoria tubular bridge is a thing of the past, although the original piers remain.

Electric Elevators.

THE increasing confidence which is being felt in the use of electricity for operating elevators is well shown by the adoption of this form for use on the Central London Railway, and a recent issue of *Engineering News* gives an excellent description of this, much the largest installation of electric elevators yet undertaken. The magnitude of the undertaking will be better understood when it is said that there are 14 stations with shafts from 18 to 30 feet in diameter and lifts ranging between 40 to 90 feet. The number of cars in each shaft is from 3 to 5, and the circular form of shafts and large loads (17,000 lbs.) required cars of very unusual shapes, thus adding to the difficulty of the work.

Owing to the opposition to the use of electricity and the pressure brought to bear in favor of hydraulic elevators, Mr. F. J. Sprague made several propositions to convince the commission of the capability of electric elevators to meet the requirements, and the final acceptance of the electric type was made contingent upon the successful performance of a complete shaft equipment, to be tested during the progress of the main equipment. This preliminary plant, consisting of the equipment for an 18-foot shaft, sustained the very rigid tests in a satisfactory manner, and the work on the entire installation is being rapidly pushed to completion.

There is nothing especially new in the design of the elevators the work being rather an adaptation of old methods to meet the difficult requirements of the heavy service specified. The hoisting portion is of the winding-drum type, operated by duplex tandem worm-wheel system driven by electric motors of the four-pole enclosed railway type. When running at 470 revolutions per minute they give an elevator speed of 200 feet per minute, and when a descending car is loaded the motors generate and return current to the line.

Especial care has been taken to introduce efficient safety devices, there being not only a spring jaw clamp, but an oil-buffer system, together with electric limit stops for each car.

One of the requirements of the specifications was that an efficiency of 70 per cent. should be obtained, and in the contract test an efficiency varying from 70 to 75 per cent. was actually shown from the current at the brushes to the work on the ropes.

THE BRITISH PRESS

A National Physical Laboratory.

THE publication of the report of the committee of the treasury upon the subject of a national physical laboratory forms a most interesting contribution to general information as to the work which should be done at a public institution of this kind in England, and which is now being done in Germany and elsewhere; and, even if the recommendations of the committee are not at present adopted, the report is a valuable document in itself.

At the present time there are in England several places at which standards of various kinds can be compared, and a limited amount of original investigation work done. The Standards office and the Electrical Standardising Laboratory afford opportunity for the commercial comparison of ordinary devices for weighing and measuring, but are by no means equal to the far more delicate and difficult work involved in the origination of new standards.

The testing work carried out by a committe of the Royal Society at Kew observatory, including the rating of watches and chronometers, and the comparison of thermometers, barometers, and similar instruments, is excellent so far as it goes, but the limited means available naturally restricts the scope of this very useful institution.

In Germany the work of the two great institutions at Charlottenburg, the Physikalisch-Technische Reichsanstalt, and the Mechanisch Technische Versuchsanstalt has been conducted with such thoroughness and accuracy as to make the names of these laboratories known all over the world. In both of these instances the testing appliances are far more complete than those at present available in England, and it is well known that English manufacturers are frequently compelled to apply to these institutions for certain tests.

Their high reputations also give such value to the certificates which they issue that investigations which might be conducted at home are sent to Germany instead, and it must be admitted that, in respect of public institutions for scientific researches of this kind, Germany is far ahead of England. France also has the advantage of possessing the Bureau International des Poids et Mesures, although the work conducted there is confined to a limited field.

In order to provide for this deficiency in England, the committee submits a very practical and reasonable proposition. Taking Kew observatory as a basis, it is proposed to extend it into a National Physical Laboratory, by the addition of new buildings, the whole to be under the direction of the Royal Society in connection with the Board of Trade.

The idea is to establish a laboratory which shall not only undertake such public standardisation and research as may be officially required, but also make tests, comparisons, and verifications for private individuals on the payment of a fee, the institution being available for government departmental work as well.

The results of investigations undertaken at the request of private individuals should, except in special cases to be approved beforehand by the governing body, be published or be accessible to the public, even when the cost of the investigations is fully defrayed by the persons in question.

Whether such a laboratory will ever be constructed remains to be seen, but the character of the committee and the high standing of its members, together with the reasonable nature of its recommendations, give some cause for hope. Especially at the present time, when attention has been so generally drawn to the rapid commercial progress made by Germany as a direct consequence of the development of technical education, it is reasonable to suppose that such an institution might be regarded as a desirable, if not a necessary, investment.

Empire and Engineering.

A RECENT editorial in *Engineering* discusses in a decidedly comprehensive manner the important and close relation which engineering bears to political and industrial conditions,—a relation which is growing closer and stronger as the century draws to a close. "The engineer, not the mere political agitator, is thus the real revolutionist, and a little consideration shows that many of the social and economic problems of the present day are the results of his operations."

This is doubtless true of many countries, notably of the British Empire and of the United States, and it is interesting to note, even briefly, the great extent to which existing political relations are directly due to the advance of engineering works.

"Railways are most important factors in bringing about some of the political problems of the day. No one who has studied the question can doubt that the great Trans-Siberian Railway has been the cause of many of the troubles in the far east. Not only was Russia determined to have a port on the Pacific coast which was free from ice all the year round, but the changes and developments which are taking place in her industrial and commercial organisation, and the rapid increase in her population, compelled her to find an outlet for her products and her surplus people."

"If the Nicaraguan Canal were available, as it or some other similar undertaking is certain to be sooner or later, we should have a great revolution in the carrying-trade of the world." The changes which are taking place in the British colonies as well as in America indicate that in the not very distant future a great change in the position of the centre of magnitude of the world's trade and industry will be seen, and that Britain cannot hope to retain the proportion which she has hitherto held. Certain it is that, if Britain is not to be left behind in the transformations which are being wrought by engineering in political relations, she must take an active part in the work which is to exercise a controlling influence on trade and dominion.

The development of railways in India has hitherto been directed toward internal improvement and conservation, but it is now a question for serious consideration whether the time has not arrived for the construction of a railway which shall secure a short route and a rapid run to India. "Recent events in Africa have opened up great possibilities for the engineer, and it is safe to say that in a comparatively short time there will not only be a railway from Cairo to the Cape of Good Hope, but that the African continent will be intersected by railways in many directions, which will cause developments which are certain to have important results on industrial, commercial, and economic conditions."

Not only railways, but, even to a greater extent, the work of the shipbuilder and marine engineer affect the growth of empire. "It is curious to see how things hang together. The Spanish-American war in itself was a comparatively insignificant and one-sided struggle, but it marks an epoch, and in a sense completes the war between Japan and China, which revealed a new military and naval power. The more recent war is certain to leave its marks on history by the development of the fighting and industrial forces of the United States, and in both of these the engineer and the manufacturer will play an important part."

It is very certain that the political changes which have resulted in the displacement of mediæval methods of rule and life by those of the end of the nineteenth century will be followed by developments due to commercial enterprise led by engineering works and methods of thought, and that the military engineer will be followed closely by the civil engineer, to the great and lasting benefit of the scenes of his labours.

The Protection of Iron and Steel.

ONE of the most serious questions to be considered in connection with the increasing use of iron and steel for all kinds of structural work is that of protection against corrosion, the greater liability of steel to corrosion being especially a matter of importance.

On this account the paper presented recently before the Society of Engineers by Mr. Sherard Cowper-Cowles upon protective metallic coatings for iron and steel is worthy of notice, and some extracts may be made bearing especially upon the principles which must be observed, if success is to be obtained.

The fundamental principle in the preservation of iron or steel from oxidation is the exclusion of air and moisture, which may be effected either by the use of non-metallic substances, such as the various protective paints, or by metallic coatings, such as zinc, cadmium, or copper. Mr. Cowper-Cowles devotes his discussion chiefly to the metallic coatings, since these, when properly applied, form the most effective means of protection, their use being recommended even when the work is to be painted.

If the coating could be made absolutely continuous, so that no air or moisture could penetrate to the steel, the action of the elements would be entirely transferred to the coating metal, and this, in all cases, is the result desired. It is practically impossible, however, to prevent the existence of pin-holes and similar microscopic breaks in the continuity of the coating, and, unless some additional protective feature be added, the oxidation will go on beneath the coating, the effect being all the worse because concealed.

The additional protection which can be afforded is that of galvanic action, by which such corrosion as is produced takes place upon the coating metal, and not upon the one which it is desired to protect.

This galvanic protection is best afforded by a coating of zinc, and it is mainly to methods of producing satisfactory deposits of this metal that Mr. Cowper-Cowles's paper is directed, although the use of cadmium, copper, and possibly aluminum is also considered.

"Iron coated with zinc, after a short exposure, becomes covered with a thin film of oxide, which gradually passes into a basic carbonate and adheres tenaciously, forming a protective covering to the zinc. So long, therefore, as the zinc surface remains intact, the underlying iron is effectively protected from corrosive action. The nature of the protective influence of the zinc on the iron is galvanic, zinc being electro-positive to iron. Two metals in contact in the presence of moisture form a galvanic couple, and the result of the galvanic action set up under these conditions is analogous to that which takes place in a galvanic battery,—*viz.*, the electro-negative element remains unaffected so long as the action continues, the intensity of the chemical action being governed by the relative positions of the two metals in the electro-chemical series."

It is important that the coating metal should be positive to the iron; else the galvanic action will accelerate the corrosion of the metal to be protected. Tin and iron, and copper and iron, standing some distance apart in the series, give rise to a decided galvanic action, in which the iron, as the electro-positive metal, is corroded more rapidly, if the continuity is once interrupted, than if it were not coated at all.

The ordinary process of "galvanising," as it is called, is well known to be the covering of the iron or steel with a coating of metallic zinc by immersion in a bath of the molten metal, and for many objects this method, used for so many years, is still well adapted. Galvanizing involves, as a preliminary to the production of a perfect coating, the removal of the mill-scale and the production of a clean surface, which result is usually accomplished by pickling in dilute sulphuric or hydrochloric acid. For sheet iron, or for articles in which strength is not a material feature, this is unobjectionable. It has been clearly shown, however, by the tests of Ledebur and by practical experience, that pickling materially reduces the strength of the metal. The cause of this action is not yet clearly established, although the experiments of Messrs. Johnson and Reynolds point to the possible combination of the iron with the liberated hydrogen and the formation of a brittle alloy.

These and other objections to the hot process of galvanising are avoided by the use of the cold process, in which the zinc is deposited by a true galvanic action. When electro-zincing is adopted, the metal can be prepared by the use of the sand blast without the employment of acid, and tests have demonstrated that iron or steel coated with zinc by electro-deposition is not at all affected in strength. Mr. Cowper-Cowles gives numerous details which must be observed in order to insure success in the electrical deposition of zinc, and the increasing extent to which the process is being applied for boiler tubes, wire, and numerous articles of mechanical importance demonstrates that this method of coating is of much value.

In regard to the use of pigments for protection against corrosion some interesting points are brought to notice.

"Experience shows that pigments, usually metallic oxides or carbonates, act as carriers of oxygen from the air to the underlying iron, causing it to rust. An ideal paint should have a toughness which does not depend on a perishable ingredient; its elasticity should not be diminished by cold; it should not soften, but rather harden, by heat; it should contain no solvents but turpentine, which experience proves to be safe; and it should contain nothing which would act as a carrier of oxygen to the metal.

"The durability of painted ironwork, therefore, largely depends upon the surface of the metal being properly cleaned and prepared. An excellent surface in this respect may be obtained at a very small cost by 'zinc flashing,'—that is, coating the iron or steel, after pickling, with a thin coat of zinc, which will resist the effects of the weather, and retain a perfect surface for receiving a coat of paint until such time as it can be applied."

Methods of Dealing with Coal Dust.

COAL dust has always been one of the difficult subjects to be dealt with in mining, and various methods of dealing with it have been evolved. A paper in the *Colliery Guardian* reviews the progress which has been made in this direction during the past few years, showing the manner in which the problem has been attacked.

"From the moment that the coal is exposed in the face until it is sent to market it seizes every available opportunity to make dust, and naturally the softer and more tender the coal, the greater are its dust-forming proclivities. This goes on in the working-places in the operations of undercutting, breaking-down, and loading; during haulage and even during winding; at the surface in the tipplers, screens, belts, and loading shoots; and, finally, in the wagons or carts that remove it from the colliery. Suggestions have been made for attacking the problem at every one of these points, and most of them have been put to work in some locality or other."

In Germany, in the Saar district, the Meissner system has been used for dampening the coal before working it at all. This method employs boreholes which are plugged water tight, and into which water is forced under pressure and given time to soak into the coal. The result is that very little dust is brought down with the coal, and in some cases the boreholes made for this purpose can also be used in wedging down the coal. Where the nature of the coal will permit, this method is very effective, but for hard, non-porous coal, especially when there are many cracks, it is obviously impracticable.

In the operation of cutting the coal, more dust is produced by machines than is the case with hand cutting, and all that can be done in either case is to moisten the cuttings before they are loaded, both as a measure of safety and in order to keep the air of the mine pure.

When the coal is down and ready for loading into the tubs, is the usual time for the first effective application of water, and then the advantage of pipe systems is seen. Water can be brought into the face in any quantity by a hose, and used either before or after the coal has been loaded, the former practice having the advantage of preventing the dissemination of dust during the loading.

If the coal is wetted in the tubs a system of overhead perforated pipes may be used, a valve being struck as each car passes under, turning on the water momentarily and sprinkling each tub to any predetermined extent. It is desirable that a minimum amount of water shall be used in any case, not so much to economise water as to avoid increase in the weight hauled, since it has been found in practice that the resultant total weight of water amounts to a very material addition to the load on a large output.

A proper wetting during or immediately after cutting greatly reduces the after formation of dust, and a judicious location of the tipplers and screens at the surface will prevent much dust from being carried down the shafts with the ventilation. General care in frequent removal of loose coal, shale and dirt from the floor will also prevent the formation of dust which would otherwise result from the grinding up of this loose material by car wheels and horses' hoofs.

All these precautions, however, will not prevent a gradual accumulation of dust in a mine, and unless some effective method is adopted for keeping it down it will become a certain source of discomfort and possible danger. Formerly salt scattered about in a dry or damp state was used for this purpose, and steam has also been employed, but both of these methods are now going out of use.

Salt water, on the other hand, has been widely adopted in the place of pure water, as it has two advantages over the latter. It keeps the dust moist for a longer time, and tends to form a crust over the dust or even to cause the whole mass to cake together. Water containing clay in suspension is also used in preference to pure water, as it has a binding action somewhat similar to that of salt water, but it cannot be prepared and used so easily, and water containing a small portion of cement distributed in it has been suggested. Various forms of spraying jets and watering carts have been devised for distributing the water, some of the carts having closed tanks containing compressed air to enable the water to be sprayed in all directions, and others being made with revolving sprinkling brushes.

By employing some of these methods, or modifications of them, much of the danger from dust explosions may be prevented, and by the use of similar precautions when the accumulations of dust are periodically removed, an important detail in coal mining may be successfully handled.

Relations of Employers and Employees.

A VERY thoughtful and interesting discussion of the important subject of relations between employers and employees is contained in the presidential address of Sir Benjamin C. Browne, delivered before the North-East Coast Institution of Engineers and Shipbuilders, and, in view of the conflicting opinions held in England and America, and the changing conditions of present workshop methods, his leading points are worthy of notice.

After showing that it is decidedly better for employers to deal with unions rather than with the men as individuals, representative action on both sides thus being had, the demands which employers are likely to receive from workmen are classified as follows: (1) demands which benefit the workmen, and are also beneficial or not injurious to the employer; (2) demands which are beneficial to the workmen, and which, at a greater or less sacrifice, the employers can afford to give; (3) demands which are beneficial to the workmen, but which the employers cannot afford to give, either on account of their own interests or on account of the trade; (4) demands which are not really beneficial, even to the workmen. In the first class, as examples, are mentioned the weekly payment of wages, the judicious regulation of over-time hours, and similar questions, which, although their introduction may cause the employer some inconvenience, ultimately are beneficial.

In the second class a reasonable demand for increased wages may be placed, while a demand for an increase above what the employer can possibly afford to give comes under the third head.

Under the fourth head come a number of points which have recently been in dispute, and which, when summed up, involve the right of the employers to the control of works. An excellent illustration of the necessity of concentrating the control in the hands of the employers is that of the man at the wheel on a steamship; just as no one is allowed to interfere with the man at the wheel, so workmen cannot be permitted to interfere with the management of works. This position includes the introduction of improved machinery, and the operation of several automatic tools by one man, as well as the employment of unskilled men upon modern tools not requiring the attendance of a trained mechanic.

An important question in this connection is that of the line of demarcation between one trade and another. As a matter of fact, there can be no strictly-defined line between one trade and another, as there is nearly always a margin in which both men are equally competent, and in such cases the employer ought to be entitled to employ either. A workman ought to be willing to do anything which can be properly done with the regular tools of his trade. Thus, either an engineer or a boiler-maker may cut a hole in a plate, but an engineer should not, as a rule, be asked to work on hot iron, because he has not been trained to it.

In discussing the losses which accrue to employers and workmen as a result of strikes, the point is properly made that the greatest losses are not those of wages to the men or of business to the employers, but the indirect losses to the country at large, and hence to many who have nothing to do with the contest.

Thus a manufacturer who cannot get his steam engine, or the shipowner who cannot get his ship to sea, are but examples of the indirect loss which falls upon third parties, while the permanent loss to the trade of the country by the diversion of trade elsewhere is the most serious of all, and is equally a loss to workmen and employers,—a curse to both, a blessing to neither.

The best possible remedy for labor troubles lies in the acquisition by the employees of an interest in the business.

"We may say that, for every workman employed in our trades, there is about £150 of capital invested, and, as the average wages paid (taking men, boys, and labourers) is about 30s. per week for 50 weeks, it means that the capital required per man is about two years' wages—much the same as it costs a man to buy his house. Now, it is not very difficult to see that, if any man saved up 10 per cent. of his wages for 14 years, and could invest the money at 5 per cent. compound interest, he would then have a sum equal to two years' wages, or, as I have said, to the capital that employs him. If only a few of our men would do this, it would be a step towards identifying our interests, and, besides that, the educational value of an investment is very great. You put money into something, and it is wonderful how quickly you will learn about it, and get rid of any unsound views you may have previously held. The workman-shareholder would be a connecting link between the capitalist and the workman, and, if the men held a large enough interest, a share in the management must follow."

Losses in Power Transmission.

It is now generally appreciated that the loss in transmitting power from the point of generation to the point of application is very great, and that it often costs as much to get power to the tool as it does to utilize it at the machine. Additional figures upon this question, however, are always welcome, and some very interesting data upon the power consumed by shafting and belting are found in the paper upon the Midland Railway electric plant recently presented before the Institution of Mechanical Engineers by Mr. W. E. Langdon,

The main shaft is driven by belting from an Elwell-Parker motor, erected some years since. To drive the main shaft alone, quite free from belting, required an expenditure of 272 watts (0.36 h. p.) the shaft being 98 feet long, 2 inches diameter, with 12 bearings each 4⅝ inches long. To drive it with nineteen belts resting on it, but free from the tools, absorbs 518 watts (nearly ¾ h. p.); while the main shaft, belts, and countershafts together require 794 watts (1.06 h. p.). The power required to drive a 9½ screw-cutting lathe without any cut, while all the other machines and belts were at rest, clear of the shafting, required 381 watts, while the power absorbed when the tool was turning down a bar of gun metal at the rate of 1.1 ounce per minute was only 545 watts, or at the rate of 495 watts per ounce per minute; or in other words the lathe running light consumed 381 watts, and the work done 164 watts.

By gearing an electric motor of low efficiency direct to the same lathe, and setting it to precisely the same description of work, the power consumed was at the rate of 214 watts per ounce per minute. In each case the greatest care was taken to insure equality in the cutting power, shape, and cut of the tool, and one cut only was made.

Comparative tests were made for one, two, and three cuts effected by the same lathe when driven from shafting, and when driven by a small motor, both being geared down to the same speed of lathe.

The advantage due to direct driving is clearly seen in the following results.

When driven by belting:—

Power............	1,188 watts,
Metal cut.........	9.75 ounces
Time occupied....	2.25 minutes

being an average of 275 watts per ounce of metal removed per minute.

When driven by motor direct:—

Power.............	616 watts
Metal removed.....	9.75 ounces
Time occupied....	2.25 minutes

or an average of 143 watts per ounce per minute, thus showing the direct-connected motor to have about double the efficiency of the belt driving.

"The results would no doubt have been more interesting if obtained from larger tools, capable of doing heavier work. Under such conditions it is probable the waste of power in shafting and belting would not be so great in relation to the work done. Still it is clear that an extensive loss does take place, and that this may be reduced by driving each tool or machine direct from an electric motor. If every foot of the shafting and every machine connected with it were constantly at work without intermission of any kind, the difference would not be so marked; but this is just what does not happen. Shafting is extended down a long shop, and scores of tools are driven by it; whether they are all at work or not, the shafting has to be kept running. This entails a certain initial loss. With large tools, or machines absorbing over one horse power, there can be no question of the advantage derived from driving direct by electricity."

The Position of the Mechanical Draughtsman.

SOME time ago an editorial appeared in *The Engineer* calling attention to the position of the mechanical draughtsman, with especial reference to the high character of work expected, the very moderate pay given, and the grudging credit allowed for the ability displayed. The result has been a voluminous correspondence from both employers and employees, and a thrashing out of the subject from many points of view.

There can be no doubt that many draughtsmen are rendering good work for small pay, and that the chief who may have suggested the design and who expects to receive the credit for the completed work, very often neglects to mention the name of the lieutenant from whom he may have received most able assistance.

It should not be forgotten, however, that the position of mechanical draughtsman should be regarded, not as a permanent walk of life but rather as a state of probation in the training of the engineer, through which he must pass on his way to more remunerative and conspicuous positions. In the United States there is a saying that no one ever sees an old draughtsman, by which it is meant, not that the hard work kills them off, but rather that the draughting room is a place from which the engineering force is recruited, the ranks being filled by young men from the technical schools who again aim to acquire the practical experience which shall fit them for the work of designing and executing mechanical undertakings as competent engineers in charge.

This should be taken into account in considering the position of the draughtsman, and the possibilities of the profession ought to be included in the value of the time given to it. Taken as an ultimate occupation, there is nothing in the position of a draughtsman to attract either ability or industry, but when considered as a stepping stone to higher rank in the engineering profession, there is every inducement to hard work and varied experience.

At the same time there is undoubtedly too great a tendency for the men who are at the heads of works to ignore the share in their success which is due to their subordinates. As Professor Sweet wrote, many years ago: "There is a class of men who are never likely to have their merits justly appreciated. I refer to the great army of lieutenants—the chief draughtsman of the professional engineer, —the secretary of the society,—the professor's associate, the manufacturer's superintendent, the second engineer in the navy, the iron-master's assistant, the inventor's model-maker, the machine-shop foreman, the man to whom we always turn when we get in close quarters, the man who helps us out when we cannot find our way out ourselves. How readily the mind of the superior absorbs the thoughts and hints of his assistant, and imagines them to have been his own!"

THE CONTINENTAL PRESS

Further Experience with Acetylene.

SINCE interest in calcium carbide and in acetylene as an illuminant became so general, many applications on a large and small scale have been made, and innumerable devices have been proposed for generating and using the gas. Early in the history of the subject the well-known firm of Julius Pintsch, of Berlin, took up the investigation of acetylene, with a view of using it in connection with the illumination of railway carriages, and the results of the numerous experiments are now given in a paper in *Glaser's Annalen*, written by Dr. H. Gerdes, under whose supervision the investigations were made.

At the present time calcium carbide is sold in Germany for 30 to 40 pfennigs per kilogramme,—a price which may be lowered when the greater output of the numerous projected works is placed upon the market. This commercial carbide varies in value in proportion to its purity, and the average yield of acetylene from that now sold is 250 to 280 litres of acetylene per kilogramme, the theoretical yield from pure carbide being 340 litres.

The general rush to experiment with acetylene resulted in numerous disasters, so that warning soon was given as to its dangers. It was said to be very poisonous, to form dangerous detonating compounds with copper and copper alloys, and to be as readily explosive in the pure state as other combustible gases are when mixed with air.

These points have been carefully investigated, and the attempt made to arrive at the facts as they exist in practice. The poisonous nature of acetylene was readily tested, and it has now been clearly established that it is no more poisonous than ordinary coal gas. The second question, however, was not so readily settled.

A number of steel vessels were prepared and filled with alloys of copper with other metals, such as zinc, tin, nickel, etc., the alloys being made in the form of rods which could be filled in crosswise in such a manner as to expose a large amount of surface to contact with the gas. Each vessel was then filled with a different mixture of acetylene with oil gas, and with coal gas, and one was also filled with pure acetylene, at a pressure of 10 atmospheres, a small quantity of water being also added to insure the presence of moisture. The vessels were then permitted to lie on an exposed roof for nine months, subject to the heat and cold of summer and winter, after which a careful examination was made of the contents. The results were negative, no acetylides being found of any explosive character whatever. It was determined, however, that pure copper would form a detonating compound with acetylene, but only after long contact of the copper with large quantities of the gas,—conditions which are not met in practice.

It is now clearly established that pure acetylene does not explode at ordinary pressure, and that any decomposition or polymerisation effected by heat is not transmitted through the mass, but is limited to the point of application of the heat. Such explosions as have been caused by the application of heat to closed vessels containing acetylene have occurred only after the heating has caused such an increase in pressure as to permit explosion.

Under these circumstances it may be accepted that pure acetylene may be generated and stored in an ordinary gasholder with no more risk than is involved in similar work with the ordinary illuminating gas, and, so far as safety is concerned, it may be used freely when only reasonable caution is exercised.

Dr. Gerdes prefers to generate the gas by plunging the carbide into a comparatively large bulk of water, and in the apparatus which he shows there is little novelty other than in minor details of arrangement. Since the apparatus is designed for the generation of acetylene to be mixed with oil gas for the purpose of storage in cylinders for use in lighting railway carriages, it is important that the predetermined mixture should be maintained. This is accomplished by the use of two meters, through which the oil gas and the acetylene are respectively passed, the drums of the meters being so geared together as to deliver the desired proportions of the two gases into the mixing main. The proportions usually employed are 75 per cent. of oil gas and 25 per cent. of acetylene,—a mixture which gives four times the illumination obtained from oil gas used alone.

To determine the danger of using the mixed gases compressed in cylinders, numerous experiments have been made, and it has been found that neither shocks or heating, within the possible limits of practice, produce explosions in mixtures containing less than 50 per cent. of acetylene, provided no oxygen is present. The assertion is distinctly made that there is no greater danger with the compressed mixture than with compressed coal gas, or even compressed air.

Herr Gerdes gives some interesting points about the production of phosphuretted hydrogen when impure carbide is used, and shows the importance of purifying acetylene generated from such material.

The Power Plant at the Paris Exposition.

THE department of motive power at the Paris Exposition of 1900, the plans for which are now made public in the *Genie Civil*, will be far more complete and extensive than has been the case at any previous exhibition, and for many reasons this portion of the display will be more attractive and interesting than has previously been possible.

In 1889 the various exhibits of steam generators were installed in temporary structures provided by the exhibitors, and the piping was conveyed in a somewhat independent fashion to the engines in the machinery hall; in the coming exhibition there will be a unity about the power plant which cannot fail to be a great improvement.

The total amount of power estimated as necessary is 20,000 h. p., of which 15,000 is allotted for lighting and 5,000 for motive power. This is only an estimate, which may be modified should occasion demand, but it is the basis upon which the present preparations are planned. Upon this assumption there is allowed a consumption of 440,000 pounds of steam per hour, or, for 205 days at 7 hours per day, a total of 631,400,000 pounds of steam for the entire period. It is estimated that this will require a consumption of about 200 tons of coal per day. The water required for condensing purposes is estimated at more than 280,000,000 cubic feet for the whole period of the exposition, and the arrangement adopted contemplates the use of this large volume of water in connection with a large cascade in the Champ de Mars.

The boilers are to be placed in two houses symmetrically disposed on opposite sides of the Champ de Mars, one of these being for French exhibitors and the other for foreigners, each boiler-house having its own chimney, and a system of flues beneath the ground permitting connection of every boiler with the chimney,

The unsatisfactory appearance of a number of separate chimneys, such as were seen in 1889, will thus be avoided, and the two great stacks can be designed to harmonize with the surroundings in such a manner as to add to the effect.

Owing to the character of the classification of exhibits, there will be a need for power in many widely-separated parts of the exposition grounds; hence the distribution of power must be effected almost entirely by means of electricity, shafting being adopted only in cases in which the driven machines may require it, and the shaft being then placed beneath the floor and driven by an independent motor. Thus there will be very little visible belt-driving, and consequently a marked improvement in the interiors of the buildings containing machinery.

In accordance with the idea of keeping transmission out of sight, all piping will be placed underground in subways constructed for the purpose. These subways, which will be nearly 9 feet in height and from 7 to 9 feet in width, and which are now in process of construction, will contain the large mains for the delivery and discharge of the condensing water, as well as the general water-supply pipes and the steam mains, so that full access can be had at all times to any of the pipe systems without breaking ground; moreover, the inconveniences inseparable from the use of steam pipes laid directly under the floors will be avoided.

It is assumed that the quantity of steam demanded by the exposition will require at least 80 boilers, the adopted unit being a capacity of 5,500 pounds of steam per hour, and the boilers are to be placed back to back along the centre of the boiler-room, the smoke flues being in the centre, beneath.

The general arrangement under which the motive power department of the exposition is to be operated is that of a system of exhibits installed and operated by the exhibitors, and subject to all the rules of the exposition, the power to be paid for by the administration at regular predetermined rates. Each exhibitor is to bear all the expense of the installation of his plant, as well as the cost of its operation, and is to agree to keep it in operation during the 205 days of the exhibition (from April 15 to November 5). The remuneration for this service is to be divided into two parts: the sum of 1,500 francs for every 1,000 kilogrammes' productive capacity of steam per hour; the sum of 4.45 francs for every 1,000 kilogrammes of steam furnished for use. The pressure of the steam is to be 10 kilogrammes per square centimetre (142 pounds per square inch).

The generating units are to consist of steam engines and electric generators combined, each engine being required to be directly connected to its generator without the use of any belt or rope transmission. Each unit may be furnished by a single builder, or the engine may be furnished by one firm and the generator by another.

Three standards of current have been adopted, to which the generators are to be limited,—namely, a continuous current of 125.250, or 500 volts; an alternating current of 2,200 volts and frequency of 50; and a three-phase current of 2,200 volts and a frequency of 50.

As in the case of the steam generators, the remuneration for the electric power is divided into two portions, one for the plant and the other for the operation, as follows:

Installation, per h. p.	Engine.	Dynamo.	Total.
For each of the first 1,000 h. p.	9.95	4.08	14.03
For 1,000 to 1,500 h. p.	7.10	1.25	8.35
For all above 1,500 h. p.	5.20	0.95	6.15

Operation, per h. p. hour.	Engine.	Dynamo.	Total.
For each of the first 1,000 h. p.	0.00840	0.00707	0.01547
For 1,000 to 1,500 h. p.	0.00382	0.00293	0.00675
For all above 1,500 h. p.	0.0028	0.00240	0.00528

These figures, which represent francs, may be of interest in connection with the various rates charged for power elsewhere, in view of the general discussion of the cost of steam power.

Metallic Sleepers for Railways.

THE use of metallic sleepers has been discussed at much length upon various occasions, but the only wise judgment which can be formed upon so important a matter is that based upon long experience.

Nearly twenty years ago—*i. e.*, in 1880—this subject was taken up by the Liége-Limburg Railway, in Belgium, sections of the road being laid with metallic sleepers of various kinds, in order that definite information concerning them might be experimentally obtained.

A report upon the results of these tests is now made public in a communication to the International Railway Congress by M. Ch. Renson, and published both in the *Bulletin* of the Association, and in *Stahl und Eisen*.

Since 1881 the engineer of the Liége-Limburg Railway, M. J. W. Post, has taken each year some current pattern of sleeper and fastening, in many cases adding or suggesting practical modifications and improvements. Trial sections having been laid with the various styles of sleepers, these sections were specially watched and carefully maintained, a minute account of the time spent on their maintenance being kept. A comparative section of road laid with standard sleepers of sound oak was also watched under the same conditions, in order to furnish a basis of comparison with the various experimental portions.

As might naturally be expected, the greatest defects were found in the form earliest laid, but even with this form there appeared distinct advantages over the oak sleepers.

In order to obtain a clear idea of the nature of the tests, a brief enumeration of the conditions must be given, and a fuller account will be found in the paper itself.

The ballast of the road is cinders, sand, or gravel, the rails being of steel, of the Belgian State pattern, weighing 77 pounds per yard, of lengths of 39½ and 29½ feet. Where the line is straight, there are thirteen sleepers to each 29½ feet, and ten sleepers to each 29½ feet, and, where there are sharp curves, there are one or two extra sleepers per rail. The heaviest engine weighs 68 tons, the heaviest load per axle being 13.9 tons, and the maximum permissible speed is 46½ miles per hour. During the seventeen years in which active experiments have been conducted the number of trains which have passed over most of the sleepers exceeds 100,000, and in one section, laid in 1881, more than 149,000 trains had passed up to January 1, 1898.

The earlier forms of sleepers were little more than a straight rolled channel, with holes punched to receive the bolts for holding the rails, and the subsequent modifications were at first mainly devoted to changes in shape and section.

On the comparative section which was laid with oak sleepers all of the 1,120 oak sleepers were withdrawn for various defects at the end of thirteen and one-half years, and the average life of oak sleepers on the road may fairly be taken at thirteen years. The corresponding average life of the earliest and crudest form of metallic sleeper was eighteen years; most of these failed from cracks originating in the punching of the holes and developing under the action of trains. Taking these inferior metallic sleepers in comparison with the oak sleepers, and allowing interest at four per cent. for the respective periods upon the first cost, it appears that the yearly cost of the oak sleeper is 41 centimes, and that of the metal sleeper is 19.5 centimes. The metallic sleepers, however, showed a higher cost for maintenance than those of oak, but, deducting for this, there still remained a yearly advantage of 10 centimes in favor of the metal sleeper.

A great portion of the loss of metal sleepers being due to cracks forming from the oblong punched holes, M. Post endeavored to use a sleeper which would permit the adoption of drilled holes and possess other improvements which experience had suggested. The result is a sleeper which has a greatly increased life, and which appears in many ways to be especially adapted for general use. This sleeper is rolled flat, and then stamped as a whole, to the required shape, in a hydraulic press, the material being a mild steel. A rectangular channel on the under side provides a recess which prevents the bolt-heads from turning, and an edge reinforcement is rolled in. The edges are turned down to form a channel-shaped sleeper, and the whole is constricted in the centre, thus increasing the rigidity in a vertical direction at the centre and decreasing the middle bearing surface. These two features greatly decrease the tendency to bend down at the ends, since the shape throws the greater amount of support under the rails, while the stiffer and narrower middle portion will sink into the ballast rather than compel the ends to bend down under the load.

The use of round drilled holes has effectually prevented the formation of cracks, and, by using square washers with eccentrically-placed holes the necessary adjustments can be obtained without making elongated holes through the body of the sleeper.

Intermediate wearing plates, placed between the rail and the sleeper, transfer the scoring due to the pressure of the rail to an easily-renewed piece, and add still more to the life of the sleeper, and with these modifications the Liége-Limburg experiments have demonstrated—to the satisfaction of M. Renson, at least—that metallic sleepers are cheaper, and in every way better, than those of wood.

Since none of the improvements added by M. Post have been patented, and since the earlier patented features described are now public property, there seems to be no good reason why, with the benefit of the experience thus freely given to the public, the use of metallic sleepers may not become general. The data and results are fully given in the report, the entire benefit of nearly twenty years' experience being thus placed at the disposal of all who may be interested.

Engineering Work on the Tiber.

THE question of river improvement has always received much attention in Italy, and there is probably no other country in Europe in which the maintenance of quay walls, the regulation of water-flow, and the general control of streams are better conducted.

A very full account of the engineering work which has been done along the historic banks of the Tiber is contributed by M. Ronna to the *Bulletin de la Société d'Encouragement*, and, while it contains nothing of especial novelty, it is an excellent example of the manner in which the rivers of Italy have been controlled from ancient times down to the present day.

After discussing the hydrography and hydrology of the Tiber and its basin, including that of the Anio, M. Ronna gives an interesting *résumé* of the history of the Tiber, gathering from many authors points of interest concerning its floods and the efforts of the Roman engineers to control them, and also illustrating and describing the ancient bridges, many of which remain, in restored and reconstructed forms. Recent work upon the river wall has revealed much of the original construction of the ancient Pons Aelius, and plans and sections of this old Roman masonry are given by M. Ronna.

Probably the most interesting historical point in connection with the Tiber of antiquity is the manner in which the shifting channel caused the ancient port of Ostia to be left on one side and to become an inland town.

Under the mediæval rule of the popes but little was done to improve the river, the maintenance of the banks being left to the occupants along its banks, but since 1870 the control of the river has been in the hands of the government engineers, and the progress since Rome has been the capital of Italy is clearly seen.

Rome naturally forms the dividing-point between the upper and lower river traffic, and thus there are two points, or ports, on the Tiber in the city, where the merchandise is handled. The upper port of Ripetta has recently been much improved, and a new bridge constructed across the river, but, since the upper stream is navigable only for boats of sixty tons or less, the greater part of the traffic occurs at the lower port of Ripagrande, from which there is a clear channel to the sea with a minimum depth of two metres. The bridges of the city obstruct traffic between the two ports, so that there is a space of more than two miles between them, and practically no water transportation of merchandise.

The most important modern engineering work on the river, however, is the entire walling-in of the river within the city limits, which, although planned during the French occupation before 1870, has been carried out since Rome was made the capital of Italy.

M. Ronna's paper contains numerous effective illustrations of the engineering features of the river, both ancient and modern, and forms an interesting contribution to the history of an important branch of engineering work.

The Water-Power of Italy.

ACCORDING to a note in the *Schweizerische Bauzeitung* the following interesting computation has been made of the total possible water-power available in Italy.

The surface of Italy is 236,402 square kilometres, and the annual rainfall is 0.8 cubic metres per square metre, which gives for the total yearly rainfall about 180 thousand million cubic metres.

Allowing one-third of the total to run off into the sea and one-third to be absorbed by vegetation and evaporated, there remains one-third, or 60 thousand million cubic metres which is caught by springs and river sources at an average height of 200 metres above the sea. This latter corresponds in its fall to the generation of about 5 million horse power. At the present time there is in Italy about 400,000 steam horse power, and 600,000 hydraulic horse power, and assuming this to be replaced from that above computed there is still left 4 million hydraulic horse power undeveloped.

These figures give some idea of the wealth which is awaiting the application of capital and industry, the Italian peninsula being especially adapted by topography and position to utilize this natural wealth to the best commercial advantage.

The Artificial Cooling of Dwellings.

At the recent convention of Heating and Ventilating Engineers at Munich an interesting paper upon modification of the heated atmosphere of summer by artificial cooling was presented by Herr Brückner, and the subject was discussed at some length, a report of the proceedings being given in the *Gesundheits-Ingenieur*.

The introductory portion of the paper reviews the various methods adopted to make the variations in climate less onerous to mankind, especially in the matters of warming dwellings in winter and the use of ice for household purposes in summer, and then proceeds to examine the possibilities of artificial cooling of the atmosphere in summer.

Two questions at once appear in connection with the cooling problem: the possibility of maintaining artificially a reasonably uniform cool atmosphere in summer, without producing too high a degree of humidity; and the possibility of doing so within a practicable limit of cost.

Artificial cooling at the present time is usually accomplished by some form of compression machine, these having very generally superseded the earlier forms of absorption machines. Herr Brückner goes somewhat into detail concerning the performance of the ammonia compression machine,—which is well-known in its construction and action and need not here be discussed,—and advocates for this especial purpose the ammonia machine with indirect brine circulation, the temperature of the brine not being necessarily as low as the freezing-point of water. A coil of pipe, with sufficient cooling surface, can readily be made to lower the temperature of the air, acting much as does the ordinary indirect system of steam-heating apparatus.

The question of humidity, concerning which there has been some discussion, is ingeniously treated by Herr Brückner. It is well known that the capacity of air for moisture is dependent upon its temperature, and that warm air requires a much greater amount of water for its saturation than does cold air. Warm air which is not fully saturated becomes saturated, therefore, when cooled below the dew point; and this effect is readily produced when a moist summer air is cooled by only a few degrees. If the air, however, is cooled to such an extent that much of the moisture is precipitated, either as dew or in the form of frost, a definite amount of the moisture is thus removed, and this cold air, when mingled with a portion of warmer air, will absorb moisture from it, and the cooling operation may thus be made a sort of drying process. It is this principle which may be used to avoid the production of an inconvenient degree of humidity in connection with artificial cooling. By cooling the incoming air in a chamber in which the coils are placed the temperature may be lowered to the dew point and a large portion of the moisture deposited, and then any desired degree of temperature and humidity may be obtained by mixture with incoming air, and the resulting atmosphere delivered to the apartments.

The question of cost is one which can be deduced only from existing refrigerating installations. While it is probable that a cooling plant at present would be too expensive for a single private residence, it is probable also that an installation for the service of a number of houses would bring the cost down to a reasonable price. At least, the plan is well worthy of consideration in connection with hospitals and institutions in which the condition of the atmosphere plays so important a part in the treatment of disease, and for vessels in tropical climates some rational and manageable system of maintaining an endurable temperature should be possible.

Land and Water Transport.

THE question of the relative advantages of land and water transport for merchandise is one which must always be complicated with local conditions; but, as the varied conditions which surround existing roads and waterways often compare closely with those of projected works, the data obtained from experience in one location may be used for another.

An editorial review in the *Moniteur Industriel* discusses the question as it exists in France, making use of some data from the recent work of M. Colson, showing the conditions under which transport by rail should compete favorably with that by water.

Taking the coal traffic from the department of the Nord to Paris by canal, the cost, under the most favorable conditions, is about 0.01 francs per ton-kilometer, being as often above as below this figure.

On the French railways, under similar conditions, the cost per ton-kilometer is about 0.242 franc; but this figure is not properly comparable with that for canal transport. In the case of the railway the cost of transport includes a proportional share of the original cost of construction as well as the subsequent maintenance, while in France both the original cost and the maintenance of the waterways is borne entirely by the government. The figures for the railway also include the provision and maintenance of stations and terminals, with all the facilities for handling the merchandise, which are lacking in the case of the canal, and, when the proportional deductions are made for these portions of the cost, the two modes of transport show little or no difference in cost. In other words, in France at least, it is the shipper who bears all the cost of transport by rail, while with the canal a considerable portion of the expense is distributed among the tax-paying public.

When there is no competition between railway and canal, there is no good reason why the railway rates should be forced down, and, even where there is a waterway paralleled by a railway, there seems to be a general understanding that the rates by rail should be at least 20 per cent. higher than by water.

The question has arisen whether, when a railway is overcrowded, it is better to relieve the congestion by the construction of a waterway or by the addition of parallel tracks; M. Colson is plainly of opinion that, unless there is some very decided advantage in favor of the canal, such as the canalization of a convenient river, it is far better to increase the railway capacity.

In the same connection, a succeeding paper on the matter in which the navigation of the Rhine has been developed shows the commercial value of a natural waterway aided by judicious improvements.

The Rhine, in the course of its navigable length, contains seventy ports, of which fifty are places of commercial importance. These latter may be divided into three classes:

1. Those which serve as terminals for inland railways, and may be called ports of transit, such as Kastel, Bingerbruch, Homburg, and Gustavburg;

2. Ports of importation, such as Mannheim and Ludwigshafen, which are in communication with all the great ports of the world, and are really the terminals of the main navigation of the river;

3. Ports of exportation, such as Ruhrort, Duisburg, Hochfeld, etc., which furnish Amsterdam and Antwerp with return freights.

Between 1860 and 1894 there has been spent for improvements in the navigation of the Rhine more than 400,000,000 francs, of which one-fourth has been furnished by Holland and three-fourths by Germany. The work has all been executed according to a predetermined plan, under the direction of a special commission, and care has been taken that there should be at all times a general uniformity in the depth and capacity of the channel, the progress on the various sections being controlled with that end in view.

The result of the improvement works has been a continued increase in the commerce of the river. In 1860 the tonnage of the Rhine in wooden bottoms was 1,581,781 tons, and in iron vessels 1,112,077 tons, while in 1890 the corresponding figures were 12,183,393 tons and 13,416,388 tons. A corresponding increase is observable in the number of steamboats, both for towing by direct haulage and by the chain drum system, and the general dependence of the increase of traffic upon increased facilities is fully demonstrated.

The cost of transport upon the Rhine corresponds very fairly with that on the French canals, averaging about 0.012 franc per ton-kilometer.

It must not be forgotten, however, when considering the importance of the traffic on the Rhine, that the river occupies a peculiar position. While it furnishes an important outlet for German products, it at the same time has at its mouth three ports of the first importance, which are in foreign territory. There is, therefore, in Germany a decided effort to divert as much of the internal water traffic as possible to the Elbe and the Weser, and thus promote the interests of the German ports of Hamburg and Bremen. At the same time there is a strong railway competition on both banks of the Rhine, which is under German control, and this causes the rates for the transportation of goods to be kept down to the lowest practicable scale.

These facts must be taken into account in making comparisons between the true cost of land and water transport from the experience obtained on the Rhine; but, when allowance is made for the local conditions, the true value of a highly-developed natural waterway may be fairly well determined.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine, printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S.A.R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, N. Y.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, O.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs. and Surveyors. Peoria, Ill.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc of Eng. *b-m* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.
Mitt. aus d. Kgl. Tech Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienn
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

College Buildings.

The New Buildings at Princeton University. The new library and new dormitory building are illustrated and described. 1700 w. Sci Am—Oct. 29, 1898. No. 23669.

Columbarium.

The New Columbarium of the Odd Fellows Cemetery Association of San Francisco. Alex. F. Oakey. Illustrated detailed description of a beautiful building designed for the permanent disposition of incinerated remains, as well as for cremation. 700 w. Cal Arch't—Sept., 1898. No. 23248 C.

Dome.

Steel Dome and Spire of St. Paul's Church, Chicago, Ill. An interesting example of structural steel-skeleton framework is illustrated and described. 500 w. Eng News—Oct. 13, 1898. No. 23336.

Grain Elevator.

American Grain Elevator on the Manchester Ship Canal. Illustrated detailed description of the construction of the buildings and their equipment. 3500 w. Engr, Lond—Oct. 7, 1898. No. 23418 A.

High Building.

Lord's Court Building. General illustrated description and supplement to specification. 1600 w. Arch & Build—Oct. 1, 1898. No. 23039.

Hospitals.

Sanitary Principles in the Construction of Isolation Hospitals. G. A. T. Middleton. With ground plans of numerous accepted arrangements, viewed especially from the architect's standpoint, and emphasizing the importance of cleanliness and ample ventilation. 2500 w. Engineering Magazine—Nov., 1898. No. 23599 B.

Residence.

Suburban Residence Built of Brick. Alfred B. Harlow. Illustrated description of a dwelling of moderate extent, costing ten thousand dollars. Gives also the ground plans, and describes the details. 2800 w. Br Build—Oct., 1898. No. 23677 C.

Surburban Residence Built of Brick. Edward B. Green. Illustrates and describes a beautiful home built at a cost of ten thousand dollars. 2200 w. Br Build—Sept., 1898. No. 23067 C.

Tenements.

Workmen's Dwellings. Discusses alterations dictated by sanitary science in apartments designed for the working class. 2000 w. Ill Car & Build—Sept. 23, 1898. No. 23120 A.

Town Architecture.

The Architecture of Our Large Provincial Towns—Newcastle-on-Tyne. An interesting illustrated description, with critical comment, and something of the history of the place. 7000 w. Builder—Oct. 8, 1898. No. 23425 A.

Warehouses.

Hamburg Warehouses. Edwin O. Sachs. One of a series of papers on "Fire Protection" published in *Engineering*. Describes and criticises these buildings from the fireproof point of view. Ill. 2400 w. Am Arch—Oct. 22, 1898. No. 23635.

HEATING AND VENTILATION.

Air Supply.

Ventilation and Warming. Extracts from a report by W. Napier Shaw, on the ventilation and warming in certain of the Metropolitan Poor Law Schools, giving the writer's views on ventilation. 3600 w. Arch, Lond—Sept. 23, 1898. Serial. 1st part. No. 23126 A.

American System.

Inlet or Outlet Ventilation. Lewis W. Leeds. Describes the system formerly used by the writer and found unsatisfactory, and also the present practice. 3300 w. Ill Car & Build—Oct. 14, 1898. No. 23600 A.

Fan System.

The Fan System of Heating and Ventilating as Applied to Court Houses. Describes the system, giving illustration. 1700 w. Dom Engng—Oct., 1898. No. 23642 C.

Greenhouses.

Greenhouse Heating. Thomas N. Thomson, in the *Home Study Magazine*. Brief description of a small greenhouse and the means of heating it, that may be built by any man handy with tools. Ill. 1500 w. Sci Am Sup—Oct. 8, 1898. No. 23237.

Hotel.

The New Mills Hotel, New York City. Describes briefly the plan of Mills House, No. 2, giving illustrated description of the ventilation and heating plant. 2000 w. Eng Rec—Oct. 8, 1898. No. 23188.

Railway Station.

The Heating and Lighting Equipment of the Grand Central Station, New York. Illustrated description of the plant. 1200 w. Elec Wld—Oct. 1, 1898. No. 23087.

Recent Systems.

Recent Systems of Heating and Ventilation. R. C. Carpenter. Presents the advantages of the mechanical system. Part first is introductory to a study of the different forms of fans and of the experiments which have been made relating to their use. 1800 w. Heat & Ven—Oct. 15, 1898. Serial. 1st part. No. 23670.

Residence.

The Combination Heating and Sanitary Plumbing of a Residence. Illustrates and describes the heating and plumbing systems of a commodious residence. 2300 w. Met Work—Oct. 15, 1898. No. 23349.

School House.

School House Warming and Ventilation. S. H. Woodbridge. Discusses the peculiar conditions of the problems and their solution. 3200 w. Eng Rec—Oct. 22, 1898. Serial. 1st part. No. 23630.

PLUMBING AND GASFITTING.

Bath Heaters.

German Bath Heaters. Robert Grimshaw. Illustrates and describes water heaters in use in Germany. 3000 w. Dom Engng—Sept., 1898. No. 23057 C.

Brass Goods.

Making Plumbers' Brass Goods. Charles Vickers. Condensed from paper read at the Cincinnati meeting of the Am. Foundrymen's Assn. Suggestions for making machinery brass-work. 1000 w. Dom Engng—Sept., 1898. No. 23056 C.

Columbia University.

Plumbing Details in Columbia University Gymnasium, New York. Illustrated description of filters and hot and cold water system for swimming bath. 1000 w. Eng Rec—Oct. 1, 1898. Serial. 1st part. No. 23160.

Drains.

Some Causes of Stoppages of Drains. William A. Murray. Calls attention to points requiring care. Ill. 1700 w. Dom Engng—Oct., 1898. No. 23641 C.

Hotel Plumbing.

Plumbing in the New Mills Hotel, New York City. Illustrated description of work in a building for men earning small wages. 2000 w. Eng Rec—Oct. 15, 1898. No. 23360.

Leaks.

Leaks in Plumbing Work in Connections of Water Front and Range Boilers. A. W. Murray. Explains the causes that produce these defects. 1700 w. Dom Engng—Oct., 1898. No. 23640 C.

Ordinance.

Plumbing Ordinance in Wilkes-Barre, Pa. A copy of the ordinance regulating plumbing and sanitary matters which has been in force since July 20, 1898. 3000 w. San Plumb—Oct. 1, 1898. No. 23199.

Regulations.

Scotch Plumbing Regulations. From the *Plumbers' Review.* Extracts from a pamphlet of regulations intended to be applicable to Scotland only, but containing much of general interest. 3700 w. San Plumb—Oct. 15, 1898. No. 23639.

Sanitation.

Modern Sanitation. W. Henman. Address before the Engng. & Arch't. Section of the Sanitary Institute Congress at Birmingham, England. General remarks on the importance and progress, with consideration of plumbing, ventilation, and related subjects. 3500 w. Builder—Oct. 1, 1898. No. 23267 A.

MISCELLANY.

Addresses.

President's Address before the British Architectural Association. G. H. Fellows-Prynne. Reviews the past work of the Assn. and states the needs and aims of the future. Discussion. 12,500 w. Builder—Oct. 15, 1898. No. 23601 A.

The Architectural Association School of Design. Abstracts of addresses by the President of the Association, and by Aston Webb, with editorial comment. 5500 w. Builder—Oct. 15, 1898. No. 23602 A.

Altar.

A Bomos in Sabina. Settimio Giampietri. Illustrates and describes an old Pelasgic altar for sacrifice. 2300 w. Jour Roy Inst of Brit Arch'ts—Sept. 24, 1898. No. 23497 B.

Architectural Competition.

An International Architectural Competition. Summarizes the purposes and results of the preliminary competition for the University of California buildings. 1500 w. Eng Rec—Oct. 15, 1898. No. 23354.

Building Stones.

Tests of Iowa Building Stones. Anson Marston. From report of Proceedings Iowa Engng. Soc., Jan. 19, 1898. Tests made under the direction of the writer by students of the Iowa State Agricultural College. Results are given. Ill. 2000 w. Stone—Oct., 1898. No. 23486 C.

Use of Stone in Building. H. F. Bain, in Annual Report of Iowa Geological Survey for 1897. The selection of stone, the conditions of life which affect stone buildings, &c. 1400 w. Stone—Oct., 1898. No. 23488 C.

Church.

The Church of the Redeemer, Jerusalem. From the London *Times.* Brief historical account of the church to be dedicated by the German Emperor on Oct. 31, 1898. 1000 w. Arch, Lond—Oct. 14, 1898. No. 23494 A.

Collapsed Building.

The Govan Building Disaster. Report of the official investigation with regard to an accident to an uncompleted building in Scotland, which killed five men and injured three. 2800 w. Arch, Lond—Oct. 14, 1898. No. 23493 A.

Columns.

The Strength and the Safe Load for Cast Iron Columns. (Die Bruchlasten und die Zülassigen Belastungen Gusseiserner Säulen.) F. v. Emperger. A general review of the experiments recently made in New York, together with a comparison of the various formulas for the strength of columns with the actual results obtained. The injurious effect of eccentric loading is emphasized. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 1, 1898. No. 23529 D.

Cooling.

The Application of Refrigerating Machinery for Cooling the Air of Dwellings. (Die Verwendung von Kältemaschinen zur Lüftung von Wohnräumen.) Dr. Brückner. A discussion of the practicability of cooling the atmosphere of dwellings in heated climates by the use of artificial refrigeration, within a reasonable limit of cost, and without producing excessive humidity. 6000 w. Gesundheits-Ingenieur—Sept. 30, 1898. No. 23533 B.

Cut-Stone.

Machine vs. Hand-Cut Stone. F. R. Patch. A defense of the machine. 1100 w. Stone—Oct., 1898. No. 23485 C.

Doorways.

Two South-Saxon Doorways. J. Tavenor Perry. An account of two interesting, undoubted Saxon doorways near Brighton, Eng., with sketches. 1700 w. Jour Roy Inst of Brit Arch'ts—Sept. 24, 1898. No. 23496 B.

Elevators.

Novel Elevator Plant in the Standard-Oil Building, New York City. Illustrated description of hydraulic elevators of unusual economy and design. 2600 w. Eng Rec—Oct. 22, 1898. No. 23627.

Exposition.

The Trans-Mississippi Exposition. Octave Thanet. A description of the exhibition, giving many illustrations of buildings, and other exhibits. 4000 w. Cos—Oct., 1898. No. 23071.

Illumination.

On the History of Our Ideas Concerning Illumination. Henry Crew. Reviews the history of windows and of the progress in artificial lighting, covering twenty centuries. 2300 w. Am Arch—Oct. 1, 1898. No. 23149.

Italy.

Unknown Italy. William H. Goodyear. An interesting illustrated account of the Italian architecture in unfrequented territory, giving some facts showing the isolation and backwardness of many of the places, and other matter of interest. 4800 w. Arch Rec—Oct.-Dec., 1898. No. 23656 C.

Metal Protection.

See Civil Engineering, Miscellany.

Mistakes.

Some Mistakes of Contractors as Viewed by an Architect. F. E. Kidder. The first of a series of articles on the mistakes of building contractors. Part first discusses the mistakes of bidding too low, and the matter of time. 1200 w. Br Build—Oct., 1898. Serial. 1st part. No. 23678 C.

Notable Buildings.

The Villa Lante. Edwards Gale. Illustrated description of the ornamental gardens, fountains, terraces, &c. 1700 w. Arch Rec—Oct.-Dec., 1898. No. 23655 C.

Organs.

Organ-Building. H. Heathcote Statham. Considers a recent work by F. E. Robertson on how to build an organ. 4000 w. Jour Roy Inst of Brit Arch'ts—Sept. 24, 1898. No. 23495 B.

Repairs.

Repairing Buildings. Illustrated description of the repairs of a 3-story brick building, leaning seriously, and of the removal of iron columns and reconstruction of trusses in a 4-story building 68 ft. wide and 100 ft. long. 1000 w. Eng Rec—Oct. 22, 1898. No. 23629.

Roman Palace.

Raphael's Palace at Rome. Interesting information of this building, giving its history and gradual transformation to the present condition. 2200 w. Am Arch—Oct. 15, 1898. No. 23401.

Sanitary Papers.

The Sanitary Institute Congress, Birmingham. Abstracts of a series of papers read at the recent Congress on ventilation, drainage, water, sewage, &c. 5000 w. Builder—Oct. 8, 1898. No. 23426 A.

Stained Glass.

Concerning Stained Glass. Review of a recent book by Lewis F. Day, giving extracts and abstracts. Ill. 3500 w. Builder—Sept. 24, 1898. No. 23216 A.

CIVIL ENGINEERING.

BRIDGES.

Arches.

Hartford Memorial Bridge and Arch. Illustration and brief note relating to one of the handsomest stone-arch bridges in the United States. 200 w. Stone—Sept., 1898. No. 23035 C.

The Arch Bridge over the Niagara Rapids. (Die Bogenbrücke über die Niagara-Stromschnellen.) G. Barkhausen. Illustrated description of the new Niagara railway arch based upon the paper of the engineer Mr. R. S. Buck. 6000 w. Zeitschr d Ver Deutscher Ing—Oct. 1, 1897. No. 23528 D.

The Computation of Stresses in Monier Arches. (Ueber die Berechnung der Spannungen in den Moniergewölben.) M. R. v. Thullie. A thorough mathematical discussion of the subject, reviewing the theories of Spitzer and Monier, and giving practical applications of the formulas. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 23, 1898. No. 23520 B.

The New Metal Arch Bridge at Niagara. (Le Nouveau Pont Metallique en Arc sur le Niagara.) Raymond Godfernaux. A very excellent description of the new railway arch across the Niagara gorge, with comparisons with numerous arches on the continent, and especial reference to the Viaur Viaduct. 3500 w. 1 plate. Le Génie Civil—Sept. 24, 1898. No. 23501 D.

Bridge Disaster.

The Fall of a Bridge at Cornwall, Ontario. Illustrated account of a disaster in which a river pier and two adjacent spans fell, with such facts as have been learned as to the cause. 1200 w. Sci Am—Oct. 1, 1898. No. 23086.

Bridge Floor.

A New Brick and Concrete Bridge Floor and Roadway. Illustrates and describes a brick and concrete roadway and sidewalk bridge under construction at DeKalb, Ill. 700 w. Clay Rec—Sept. 26, 1898. No. 23399.

Budapest.

The Francis-Joseph Highway Bridge over the Danube at Budapest. (Le Pont-Route François-Joseph sur le Danube à Budapest.) A very complete account of this important cantilever, with details of the piers, structural work and erection. 4000 w. 1 plate. La Revue Technique—Sept. 25, 1898. No. 23510 D.

Distortion.

The Sectional Distortion of Iron Bridges. (Die Querschnittsverzerrungen Eiserner Brücken.) O. C. Reymann. A mathematical discussion, showing the effect which a distortion of a cross-section has upon the vertical and longitudinal members. Serial. Part 1. 4000 w—Glaser's Annalen—Oct. 1, 1898. No. 23543 D.

Exposition.

The Universal Exposition of 1900. (Exposition Universelle de 1900.) Giving an account of the present state of the works, and especially of the false works for the erection of the superstructure of the Alexander III. bridge without obstructing travel on the Seine. 3000 w. La Revue Technique—Oct. 10, 1898. No. 23514 D.

Foundations.

Bridge Foundations. A statement of the precautions which should be taken. 900 w. Eng Rec—Oct. 1, 1898. No. 23155.

Deep Bridge Foundations, Atchafalaya River. C. H. Chamberlin. Facts regarding this work in an alluvial section, where unusual depth of the piers was made necessary by reason of the instability of the soil when acted upon by river currents. Diagrams. 3200 w. Jour Assn of Engng Soc's—Sept., 1898. No. 23705 C.

Highway.

Highway Bridges. Editorial on methods of securing safe county bridges. 1600 w. Eng Rec—Oct. 15, 1898. No. 23353.

Launhardt Formula.

The Launhardt Formula, and Railroad Bridge Specifications. Henry B. Seaman. Reviews Wöhler's experiments on the fatigue of metals and the deductions which were made in 1889, placing the matter in a form for practical application to bridge construction, presenting a general specification for steel railroad bridges. 8000 w. Pro Am Soc of Civ Engs—Oct., 1898. No. 23654 F.

Maintenance.

Care of Bridges. Extracts from the committee report on this topic to the Assn. of Supts. of Bridges and Buildings. 900 w. R R Gaz—Oct. 28, 1898. No. 23689.

Modern Bridging.

The Birth-Place of Modern Bridging. The history of the first successful building of iron bridges by the Coalbrookdale ironmasters, in 1779. Ill. 1300 w. Engr, Lond—Sept. 23, 1898. No. 23142 A.

Montreal.

Reconstruction of the Victoria Tubular Bridge. An account of the work of rebuilding the tubular bridge at Montreal, giving facts of interest relating to the old bridge and some idea of the cost. Ill. 1200 w. Ry & Engng Rev—Oct. 1, 1898. No. 23220.

The Victoria Bridge, Montreal. Illustrated description of the old and new bridges. Part first is on the conditions governing the work and the construction of the piers. 4500 w. Eng Rec—Oct. 22, 1898. Serial. 1st part. No. 23624.

Pontoon Bridges.

Old Methods of Crossing Rivers by Pontoons. Gives illustrated descriptions of boats and methods used. 900 w. Sci Am Sup—Oct. 22, 1898. No. 23467.

CANALS, RIVERS AND HARBORS.

Bruges.

The Harbor and Maritime Canal of Bruges. (Les Ports et le Canal Maritime de Bruges.) An account of the extensive harbor improvements recently commenced, and to be completed in 1902, at a cost of nearly 40,000,000 francs. 1200 w. La Revue Technique—Sept. 25, 1898. No. 23509 D.

Canal Locks.

The Electrical Operation of the Locks of the North Sea Canal between Ymuiden and Amsterdam. (Der Elektrische Betrieb der Meerschleuse des Nordseekanales von Ymuiden nach Amsterdam.) F. Tischendörfer. A very complete account of the canal locks, with illustrations of the electrical windlasses, capstans and other apparatus by which they are operated. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 24, 1898. No. 23525 D.

Cedar River.

Gauging of Cedar River, Washington. Theron A. Noble. An explanation of methods used and data obtained in preparation for the installation of a water-power plant on Cedar River, the object being to transmit power to Seattle and Tacoma. Ill. 3500 w. Pro Am Soc of Civ Engs—Sept., 1898. No. 23065 F.

Dock.

A Remarkable Dock. Describes the hull of an old ship of about 800 tons which was sunk in the mud to be used as a dock, and also the new dock which is to replace it. 1000 w. Engr, Lond—Sept. 30, 1898. No. 23292 A.

Dredges.

Steam Barges, Suction Dredges, and Bucket Dredges. (Porteurs à Vapeur-Dragues à Succion, Dragues a Godets.) Especially devoted to recent French dredges constructed for use in Russia. 2000 w. La Revue Technique—Oct. 10, 1898. No. 23513 D.

Erie Canal.

New York's Canals. State engineer, C. W. Adams, discusses the report of the Canal Investigating Commission. Also editorial. 4500 w. Sea—Oct. 13, 1898. No. 23351.

Recent Engineering Work on the New York State Canals. Review of the State engineer's reply to criticisms on the preliminary work for enlarging the canals, the choice of specifications and the classification of rock and earth. 4800 w. Eng Rec—Oct. 22, 1898. No. 23625.

Flume.

The Basic Company's Flume, Idaho. Illustrated description of this work and its construction, in connection with the installation of a water-power plant at Grimes Creek to furnish electric power needed at the company's works. 2000 w. Eng & Min Jour—Oct. 15, 1898. No. 23404.

Haulage.

See Electrical Engineering, Power.

Hydrometry.

The Williams Hydrometric Cord. (Le Cordage Hydrometrique Williams.) An improved device for determining the velocity of flow in a stream by measuring the angles of deflection of the catenary formed by a cord attached, under known tension to the banks of the stream and subject to the force of the current. Formula and illustrations are given, and accurate results claimed. 1200 w. La Revue Technique—Oct. 10, 1898. No. 23515 D.

Lighthouses.

The Latest Improvements in the French Lighthouse System. Jacques Boyer. The second paper gives a very full account of the great Eckmühl lighthouse on the Breton coast, and concludes with a discussion of lightships and illuminated buoys, with many illustrations. 3500 w. Engineering Magazine—Nov., 1898. No. 23596 B.

Nicaragua Canal.

The Nicaragua Canal. Day Allen Willey. Discusses the route, the topography, the difficulties in construction, cost, the effect on commerce, and in developing the western coast of the United States. 2800 w. Chau—Nov., 1898. No. 23681 C.

See Economics and Industry, Commerce and Trade.

Panama.

The Panama Canal. Statement of work done by the international committee of engineers. 900 w. Eng Rec—Oct. 1, 1898. No. 23156.

The Present Status of the Panama Canal. Henry L. Abbot. Sets forth the work of the international engineering commission which visited and inspected the works on the Isthmus and examined the engineering problems, with the conclusions they reached. Also editorial. Ill. 5500 w. Eng News—Oct. 6, 1898. No. 23244.

Rhine.

The Regulation of the Rhine. (Die Rhein-Regulierung.) P. Krapf. A very complete account of the correction of the Rhine above the Lake of Constance with plates of maps, profiles, canal sections, and dredges. 6000 w. 4 plates. Oesterr Monatschr f d Oeffent Baudienst—October, 1898. No. 23534 D.

The Rhine (Le Rhin.) A review of the growth of traffic on the Rhine and some account of the improvements which have increased the navigable capacity of the river. 1800 w. Moniteur Industriel—Oct. 1, 1898. No. 23566 G.

Tiber.

The Tiber. (Le Tibre.) M. Ronna. An historial and technical review of the engineering works on the Tiber, from ancient times down to the present, including bridges, quays, harbors, and the general hydrography of the stream. An interesting and valuable paper. 25,000 w. Bulletin de la Société d'Encour—Sept., 1898. No. 23516 G.

Tidal Rivers.

Characteristic Particulars about a Tidal River. Leveson Francis Vernon-Harcourt. Summary of the various particulars of a tidal river, which are of importance in determining its precise condition, and enabling its capabilities for navigation to be compared with those of another river. Ill. 5500 w. Ind Engng—Sept. 17, 1898. No. 23468 D.

IRRIGATION.

Dam Failure.

The Failure of the Snake Ravine Dam, Turlock Irrigation District, California. J. B. Lippincott. Gives the history of this dam, with comments on the Wright Act, which provides for district irrigation in California. Ill. 1800 w. Eng News—Oct. 20, 1898. No. 23457.

Report.

The Sind Irrigation Report, 1896-97. A. R. Gives a short history of the Sind Irrigation Works, and a favorable report for the year. 1400 w. Ind Engng—Sept. 3, 1898. No. 23200 D.

Temperature.

The Temperature of Irrigation Fields. A review of observations with soil thermometers showing how irrigation affects temperatures. 900 w. Eng Rec—Oct. 29, 1898. No. 23693.

MISCELLANY.

Cement Testing.

German Methods of Testing Cement. Translation of articles in the official organ of the International Society for the Unification of Tests of Materials. 2200 w. Eng Rec—Oct. 15, 1898. No. 23356.

Cement Works.

Buckeye Portland Cement Plant Near Bellefontaine, O. Illustrated description of a plant which began with Dietzsch kilns and the semihumid process and now uses wet grinding and continuous rotary kilns burning powdered coal. 1400 w. Eng Rec—Oct. 15, 1898. No. 23355.

Columns.

See Architecture and Building—Miscellany.

Engineering.

See Economics and Industry, Commerce and Trade.

Metal Protection.

Lead vs. Zinc Paints. G. R. Henderson. An account of a series of exposure tests on tin, galvanized iron, sheet iron, poplar, white pine, and yellow pine. Two coats of paint were given to each. Reports results. 900 w. R R Gaz—Sept. 30, 1898. No. 23081.

Methods of Rust Prevention. (Die Mittel zur Verhütung des Rostes.) Dr. Julian Treumann.

A general discussion of various methods of rust prevention, with especial reference to structural steel and iron work. Two articles. 6000 w. Stahl und Eisen—Oct. 1, 15, 1898. No. 23564 each D.

The Protection of Metal Work in Concrete. Letter from Albert W. Buel. A compilation of statements claiming that paint is unnecessary. 1400 w. Eng Rec—Oct. 8, 1898. No. 23187.

Protective Metallic Coatings for Iron and Steel. Sherard Cowper-Coles. Read before the Soc. of Engs., England. Part first considers the causes that tend to corrode iron and steel, and will later deal with the processes for applying metallic coatings which effectively exclude air and moisture. 2300 w. Ind & Iron—Oct. 7, 1898. Serial. 1st part. No. 23412 A.

Roads.

Road Building. An informal discussion before the Society, printed that the views expressed may be brought before all the members. 16,500 w. Pro Am Soc of Civ Engs—Oct., 1898. No. 23653 F.

Tornado.

The Merriton Tornado. Orrin E. Dunlap. Illustrated account of the great destruction of property in Canada and Western New York. 900 w. Eng News—Oct. 13, 1898. No. 23333.

Tunneling.

Shield Tunneling for Sewers in Melbourne. Illustrated description of methods and apparatus used in 7 miles of sewers 5 to 12 feet in diameter. Abstract of paper read before the Victoria Inst. of Engs. by George Henry Dunlop. 6000 w. Eng Rec—Oct. 15, 1898. Serial. 1st part. No. 23357.

Vienna.

Plans of the City of Vienna at the Time of the First Turkish Siege. (Die Wiener Stadtpläne zur Zeit des Ersten Türkenbelagerung.) S. Wellisch. An account of the two maps of the city made by Hirschvogel and Wolmuet from surveys in 1547. The probable errors are determined by comparison with existing landmarks and the old methods described and illustrated. An interesting contribution to the history of surveying. Three articles. 10,000 w. Zeitscr d Oesterr Ing u Arch Ver—Sept. 16, 23, 30, 1898. No. 23518 each B.

Water Rights.

The Ownership of Underground Water. Reviews a decision of the Utah Supreme Court, on the law of underground water. 1200 w. Eng Rec—Oct, 22, 1898. No. 23621.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Brazil.

American Trade with Brazil. Reviews the iron and steel trade with this country, explaining the falling off in the 1897 trade, and giving some information concerning trade opportunities. 1800 w. Am Mfr & Ir Wld—Sept. 30, 1898. No. 23213.

Calcutta.

Trade of Calcutta with the United States, 1897-98. A report compiled from the returns of the collector of customs of the port of Calcutta, of the foreign trade for the official years 1894-1898, showing the trade with the United States. 800 w. Cons Repts—Sept., 1898. No. 23028 D.

Caracas.

The Caracas Warehouse. A description of the institution and its exhibits, which are grouped in the various rooms according to trades, the plan of organization, etc. 4000 w. Cons Repts—Oct., 1898. No. 23030 D.

Caroline Islands.

The Caroline Islands. Extract from a letter written by F. W. Christian, of the Polynesian Society of Wellington, New Zealand, giving an interesting description of the Caroline Archipelago, the customs of the natives, products, &c. 4000 w. Cons Repts—Sept., 1898. No. 23022 D.

China.

New Trade Regulations on the Yangtze. A copy of the revised regulations of trade on the Yangtze river, which will take effect after having received the approval of the foreign representatives at Pekin. 1200 w. Cons Repts—Sept., 1898. No. 23023 D.

Our Policy in China. Mark B. Dunnell. Presents the existing conditions brought about by foreign powers, and discusses what the policy of the United States should be to preserve our present treaty rights of admission to the Chinese market upon terms of equality with other nations. 6000 w. N Am Rev—Oct., 1898. No. 23207 D.

The British Record in China. Alexis Krausse. Reviews the history of the relations between Great Britain and China, and their bearing upon trade. 4800 w. Fortnightly Rev.—Sept., 1898. No. 23117 E.

The Chinese and Recent Industrial Progress in China. J. S. Fearon & E. P. Allen. A discussion of the vast industrial interests awaiting development in China together with an account of the racial and political difficulties to to be overcome. 4000 w. Engineering Magazine—Nov., 1898. No. 23590 B.

The Industrial Situation in China. Considers the alliance with Russia, the Siberian Railway, the struggle for markets, railway progress, and other business aspects. 5000 w. Ir & Coal Trds Rev—Sept. 30, 1898. No. 23280 A.

Coal Trade.

Coal Exports and National Trade. A survey of the position of Great Britain at the present time, the home industries which absorb coal in the production of steam power, the exports, &c. 2300 w. Col Guard—Oct. 14, 1898. No. 23607 A.

The Present Position of the Coal Trade and Some of Its Difficulties. William Armstrong. An address before the North of England Inst. of Min. and Mech. Engs. Reviews the present condition, the difficulties and the line of action by which they might be advantageously met and overcome. 2000 w. Col Guard—Oct. 14, 1898. No. 23606 A.

Commercial Problem.

The Coming Struggle in the Pacific. Benjamin Taylor. An interesting discussion of some of the problems to be solved in the approaching development of the Pacific. The Nicaragua canal, the cable communication, commercial aspects, and various new complications. 8400 w. Nineteenth Cent — Oct., 1898. No. 23395 D.

Denmark.

Trade with Denmark. Hints on the requirements of the Danish market in iron and steel manufactures and urging the increase of the United States trade. 1800 w. Am Mfr & Ir Wld—Oct. 14, 1898. No. 23438.

Egypt.

Trade Conditions in Egypt. Report on trade conditions, with suggestions as to the export trade from the United States. 6000 w. Cons Repts—Oct., 1898. No. 23029 D.

Engineering.

Empire and Engineering. Editorial discussion of the problems of the present time and the factors that have brought them about, especially the influence of the engineer. 2500 w. Engng—Oct. 14, 1898. No. 23617 A.

Export Markets.

The Quest for Export Markets. Gives information concerning methods of extending trade, the steps taken by Germany and France, and the needs of the United States to enable it to master the science of international commerce. 1700 w. Cons Repts—Oct., 1898. No. 23031 D.

German Trade.

German Colonial Expansion. Editorial on report by the secretaries of the British Embassy at Berlin, especially the part that deals with the efforts of Germany to gain a foothold in China. 1400 w. Engng—Sept. 23, 1898. No. 23146 A.

Harbor Regulations.

Japanese Harbor Regulations for Open Ports. Translation of the new harbor regulations promulgated by imperial ordinance. 2000 w. Cons Repts—Oct., 1898. No. 23033 D.

India.

The Iron and Metal Work in India. Interesting information relating to the advancement of these industries, the articles imported, &c. 1500 w. Ir Age—Sept. 29, 1898. No. 23070.

Lumber.

The Lumber Trade of Belgium. This is one of the most important articles in the Belgian import trade. The valuation of imports from different countries is given, and information valuable to American exporters. 3500 w. Cons Repts—Oct., 1898. No. 23032 D.

Machinery Trade.

The Swiss Machinery Trade in 1897. H. L. G. Reports a very flourishing condition. 600 w. Am Mach—Sept. 29, 1898. No. 23108.

Mexico.

Our Trade with Mexico. Showing the importance to the United States of this market, and giving report of exports. 1200 w. Am Mfr & Ir Wld—Oct. 21, 1898. No. 23644.

New York.

New York's Commerce. A statement prepared by Alex. R. Smith suggesting the scope of the inquiry and the subjects that should be investigated by the New York Commerce Commission to restore commerce. 4000 w. Sea—Oct. 13, 1898. No. 23350.

New Territory.

Commerce with Our New Possessions. E. W. Blatchford. An address delivered before the Illinois Mfrs. Assn. Presents the conditions of the United States in relation to the interests of commerce, and gives the writer's views in regard to the country's duty to the newly acquired islands. 2400 w. Dom Engng—Oct., 1898. No. 23643 C.

Nicaragua Canal.

The Nicaragua Canal. I. The Political Considerations. L. M. Keasbey. II. The Commercial Interests. Emory R. Johnson. Two interesting papers on the questions to be considered in relation to the construction of this canal. 9000 w. Am Rev of Revs—Nov., 1898. No. 23699 C.

Norway.

American Trade with Norway. Explaining the character of the Norwegian market, noting the value, amount and sources of the chief importations. 1600 w. Am Mfr & Ir Wld—Oct. 7, 1898. No. 23311.

Philippines.

Commerce with the Philippines. Statistics relating to the imports and exports compiled from official publications of the various countries mentioned, in the possession of the Bureau of Foreign Commerce. 1500 w. Cons Repts—Sept., 1898. No. 23021 D.

Commercial and Industrial Conditions in the Philippines. Extracts from the *Bulletin de la Société de Geographie Commerciale*, Paris. Discusses the market for European goods, the resources of the islands, &c. 1800 w. Cons Repts—Oct., 1898. No. 23034 D.

Russia.

The Iron Industry and Iron Trade in Russia. (Die Eisenindustrie und der Eisenhandel in Russland.) A statistical paper showing the rapid growth of the Russian iron industry in recent years. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 1, 1898. No. 23574 B.

Shipping.

The Future of Merchant Shipping. Editorial discussion of a paper by Elmer Lawrence Corthell, read before the Am. Assn. for the Adv. of Science, at Boston. 1400 w. Engng—Oct. 14, 1898. No. 23619 A.

South Africa.

Imports into South Africa. Information relating to the trade with Germany, England and the United States and the foothold gained by the last named country. 2200 w. Cons Repts—Sept., 1898. No. 23026 D.

Trade Openings in South Africa. Reports dealing with various lines of imports. Considers cold-storage plants, horses and mules, bicycles, agricultural implements, harness, lumber, coal, groceries and provisions, &c. 5400 w. Cons Repts—Sept., 1898. No. 23027 D.

CURRENCY AND FINANCE.

Sound Money.

Sound Money Misrepresentation. Discusses a monograph by Edward Atkinson which appeared in an issue of the Sound Currency Committee of New York. 2800 w. Gunton's Mag—Oct., 1898. No. 23111 C.

Surplus Revenues.

Surplus Revenues and Future Financial Legislation. Discussing the effect of the money accumulating in the U. S. Treasury as a result of the loan and the war revenues. 2400 w. Banker's Mag, N. Y.—Oct., 1898. No. 23364 D.

LABOR.

Labor Relations.

Relationship Between Employers and Workmen in the Engineering Trades. Benjamin C. Browne. Presidential address before the North-East Coast Inst. of Engs. and Shipbuilders, discussing the question stated. 4400 w. Col Guard—Oct. 14, 1898. No. 23608 A.

Strikes.

Retrospective Lessons on Railway Strikes. Review of work by E. J. O'B. Croker, with extracts. Ill. 1500 w. Transport—Sept. 16, 1898. No. 23047 A.

Wages.

The Evolution of High Wages from Low Cost of Labor. Edward Atkinson. Read before the Am. Assn. for the Adv. of Science. A statement of existing conditions of prices and wages introductory to a discussion of the views of Malthus and their errors, and drawing conclusions bearing on commerce. 5500 w. Ap Pop Sci M—Oct., 1898. No. 23068 D.

Workmen's Compensation.

Workmen's Compensation in Relation to Collieries. Showing the great burden imposed upon colliery proprietors. 1800 w. Col Guard—Sept. 30, 1898. No. 23287 A.

MISCELLANY.

Alaska.

Colonial Lessons of Alaska. David Starr Jordan. Reviews the history of Alaska, indicating lessons to be learned, giving facts relating to the fur, salmon, and other industries. 11,000 w. Atlantic M—Nov., 1898. No. 23679 D.

Ceramic Industry.

Building-Ceramic Industries in England. Translated from the *Thonindustrie Zeitung*. Descriptive account of methods and products. 2200 w. Brick—Oct., 1898. No. 23255.

China.

England's Destiny in China. F. E. Younghusband. Presents the situation in China, discussing the causes, and the steps taken by Russia and other European Powers, stating their present position and what the policy of England should be. 8000 w. Contemporary Rev—Oct., 1898. No. 23366 D.

Disarmament.

Finance and Disarmament. Sydney J. Murray. Discusses the Tzar's proposal, and what would be the effect of general disarmament. Thinks it would involve a dislocation of trade relations, all over the world. 1800 w. Bankers' Mag, Lond—Oct., 1898. No. 23365 D.

Should Europe Disarm? Sidney Low. Discusses the question of militarism and national wealth and related subjects, concluding that the time is not yet ripe for dispensing with the soldier. 4500 w. Nineteenth Cent—Oct., 1898. No. 23394 D.

The Tzar's Appeal for Peace. Presents the writer's view of the situation, and the impossibility of the Tzar's power to enforce his personal wish in this matter. 3500 w. Contemporary Rev—Oct., 1898. No. 23368 D.

Education.

The Overcrowding of the German Technical High Schools. (Die Ueberfüllung der Deutschen Technischen Hochschulen.) An address to the Prussian government by the German Society of Engineers, showing the manner in which the demand for a technical education is crowding the higher educational institutions, and suggesting various remedies. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 17, 1898. No. 23524 D.

The University and the Technical High-School. (Universität und Technische Hochschule.) F. Klein. An address showing the influence of the demand for technical training, and the importance of including a greater proportion of practical science in University instruction. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 24, 1898. No. 23526 D.

Exposition.

The Paris Exposition of 1900, and Its Leading Features. Data relating to the progress thus far in preparation for this great exposition, with illustrations and general plan. 2300 w. Elec Eng, N. Y.—Oct. 27, 1898. No. 23659.

Philippines.

What Shall Be Done About the Philippines? Mayo W. Hazeltine. Thinks the entire Philippine Archipelago should be kept by the United States, but that the signing of the protocol has made it impossible except by purchase. 3300 w. N Am Rev—Oct., 1898. No. 23206 D.

Pittsburg.

The Agricultural, Mineral, Industrial and Commercial Resources of Pittsburg and Vicinity. Thomas Bruce. The wonderful resources of this section are shown and its influence in the fields named. Ill. 22,500 w. Am Mfr & Ir Wld—Oct. 7, 1898. No. 23309.

Transport.

See Railway Affairs, Conducting Transportation.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Batteries.

A Comparison of the Electromotive Force of the Clark and Cadmium Cells. S. N. Taylor. Describes work performed at the Physical Laboratory of Clark University, and also the apparatus used and results obtained. 5700 w. Phys Rev—Sept.-Oct., 1898. No. 23658 D.

Contributions to the Theory and Construction of Galvanic Elements. (Beiträge zur Theorie und Konstruktion Galvanischer Elemente.) Dr. G. Platner. Applications of the modern electro-chemical theory to the galvanic battery, including the use of chlorate of sodium as a depolarising material. 1800 w. Elektrochemische Zeitschr—Oct., 1898. No, 23559 H.

How to Make a Dry Cell. A dry cell is merely a non spilling wet cell. Directions for making are given and some of the particular forms of dry cells considered. 2200 w. Am Elect'n—Oct., 1898. No. 23098.

Notes on the Structure and Management of Leclanche Batteries. J. Warren. An explanation of some points not generally understood, with precautions needed in the care of the batteries. 900 w. Elec, Lond—Oct. 14, 1898. No. 23483 A.

Calcium Carbide.

The Manufacture of Calcium Carbide in Switzerland. Edward A. Schneider. Reports a great advance in the manufacture due to cheap water power, the improved methods and favorable conditions. 700 w. Ind & Ir—Sept. 30, 1898. No. 23284 A.

Chemistry.

The Electric Current in Organic Chemistry. Edgar F. Smith. Address of the Vice President before Section C of the Am. Assn. for the Adv. of Science. A sketch of the progress in the electrolysis of organic bodies. 6000 w. Science—Sept. 30, 1898. No. 23038.

Chromium.

Some Notes on the Electro-Deposition of Chromium. Sherard Cowper-Coles. Gives some of the characteristics, a summary of the results of experiments carried out by Prof. Hittorf, and the investigations of Herr Eschermann, Dr. Hans Goldsmidt, Claude Vautin, and others. 1000 w. Elec Rev, Lond—Sept. 30, 1898. No. 23276 A.

Decomposition.

Studies upon the Voltages of Decomposition. (Studien über Zersetzungsspannungen.) E. Bose. A long and elaborate account of experimental investigations into the voltages at which the electrical decomposition of various compounds occur. Many tables and diagrams are given. 10,000 w. Zeitschr f Elektrochemie—Oct. 6, 1898. No. 23560 H.

Electrodeposition.

See Mining and Metallurgy, Gold and Silver.

Electrolysis.

Electrolysis of Water Pipes at Dayton, O. Extracts from the reports of experts, called to thoroughly investigate the extent of damage, and from the report of the secretary of the Dayton Water Works' Board. 2800 w. Eng News—Oct. 6, 1898. No. 23246.

Furnace.

The Electric Furnace. F. Jarvis Patten. Describes early historical forms, and recent improvements. Ill. 2700 w. Elec Wld—Oct. 22, 1898. No. 23428.

Metal Cleaning.

Electrolysis in the Cleaning of Metallic Surfaces. C. F. Burgess. Discusses methods in use for the removal of foreign substances from metallic surfaces, dealing especially with electrolytic processes, and giving results of investigations. 2800 w. Elec Wld—Oct. 29, 1898. No. 23667.

Nitrogen.

Fixation of Atmospheric Nitrogen. William Bouldin, Jr. Discusses the recent address by Prof. Crookes before the British Assn. and suggests other lines for study of this important subject. 1500 w. Am Gas Lgt Jour—Oct. 3, 1898. No. 23167.

Phosphorus.

The Electro-Thermal Process for the Manufacture of Phosphorus. John B. C. Kershaw. A brief historical review, with description of the electro-thermal method, and reasons why the phosphorus industry is in a very unsettled state. 900 w. Elec Rev, Lond—Oct. 7, 1898. No. 23424 A.

Photochromy.

The Photochromy of Metals. Translated from *La Revue Technique*. Brief account of investigations of the color effects of thin electrically deposited metallic films, by Edmund Becquerel, and Joseph Girard. 1000 w. Eng & Min Jour—Oct. 29, 1898. No. 23701.

Storage Batteries.

See Street and Electric Tramways.

Zinc.

Two Electrolytic Methods of Determining Zinc. (Zwei Elektrolytische Zinkbestimmungen.) Dr. H. Paweck. A review of preceding methods of determining zinc, and an account of the results obtained by modifying the material and character of the anodes. 1800 w. Oesterr Zeitschr f Berg u Huttenwesen—Sept. 17, 1898. No. 23571 B.

LIGHTING.

Arc Lamp.

A Submarine Arc Lamp. Illustrated description of a device which promises to be of value in diving and wrecking operations. 900 w. Elec Rev, N. Y.—Oct. 19, 1898. No. 23419.

Duflos Arc Lamp. A. Z. in *L'Industrie Electrique*. Illustrates and describes an arc lamp in which the regulation is effected by a shunt coil. 800 w. Elec Rev, Lond—Sept. 30, 1898. No. 23274 A.

The Duflos Arc Lamp. (Lamp à Arc Duflos.) A very simple arc lamp mechanism operated by an electro magnet in a derived circuit, without the use of any braking mechanism. 1000 w. Electricien—Oct. 1, 1898. No. 23554 B.

The Electrical Properties of the Vapors from the Carbon Arc. Ernest Merritt and Oscar M. Stewart. Describes experiments undertaken to study in detail the conducting property possessed by the arc vapors, giving results. 4300 w. Phys Rev—Sept.-Oct., 1898. No. 23657 D.

The Sonja Long-Burning Lamp. (Sonja-Dauerbrandlampen.) An illustrated description of an improved enclosed arc lamp of simple construction, having a burning period of from 100 to 200 hours. Elektrotech Zeitschr—Sept. 29, 1898. No. 23550 B.

Circuit-Controller.

Improved Circuit-Controller for Vacuum Tube Lighting and Other Purposes. Details of the invention recently patented by Nikola Tesla, with illustration. 2200 w. Elec Rev, N. Y.—Oct. 19, 1898. No. 23420.

Comparison.

A Comparison of Different Systems of Lighting. From a communication in the Transactions of the *Société Technique du Gaz en France*, by M. Bouvier, giving results of investigations to ascertain the comparative value of different systems of lighting. 700 w. Jour of Gas Lgt—Oct. 11, 1898. No. 23449 A.

Current Price.

Reduction of the Price of Current by the New York Edison Company. A new schedule of prices with comments and editorial. 2200 w. Elec Eng, N. Y.—Oct. 13, 1898. No. 23314.

Decorations.

Electric Lighting in the Chicago Peace Jubilee. An illustrated description of the fine effects wrought by the use of about fifty thousand incandescent lamps. 1800 w. Elec Wld—Oct. 29, 1898. No. 23664.

The Illumination at the Knights Templar Conclave. Illustrates and describes some of the features of the elaborate display at Pittsburg. 1100 w. Elec Wld—Oct. 22, 1898. No. 23427.

Enclosed Arc.

The Photometry of the Enclosed Alternating Arc. Charles P. Matthews, W. H. Thompson, and J. E. Hilbish. Experimental data of the behavior of this type of illuminant. Apparatus used, results, and comments. Ill. 3300 w. Trans Am Inst of Elec Engs—Aug. & Sept., 1898. No. 23489 D.

Filaments.

A New Incandescent Filament for Electric Lights. Information concerning the improved incandescent filament announced by Dr. Auer von Welsbach. 500 w. Cons Repts—Sept., 1898. No. 23024 D.

Incandescent.

Incandescent Lamps as Manufactured by the Shelby Electric Company, Shelby, O. A detailed account of the manufacture of these lamps, noting their principal features. Ill. 3000 w. Elec Eng, N. Y.—Oct. 13, 1898. No. 23315.

Inclosed Arc.

The Photometry of the Inclosed Alternating Arc. Charles P. Matthews, W. H. Thompson and J. E. Hilbish. Paper presented at the New York meeting of the Am. Inst. of Elec. Engs. Discusses the three reasons why the results, in so far as they involve the determination of luminous intensity, are unsatisfactory, giving tests and their results. 2500 w. Elec Wld—Oct. 8, 1898. No. 23242.

Lighthouses.

Electric Lighthouses. Recent improvements in the systems used, with illustrated description of the Penmarch light. 1000 w. W Elect'n—Sept. 24, 1898. No. 23055.

See Civil Engineering, Harbors.

Lighting Contract.

The New Public Lighting Contract in Boston. Editorial review of an agreement making the lighting company merely an agent of the city, subject to arbitration. 1200 w. Eng Rec—Oct. 1, 1898. No. 23153.

Lighting System.

An Experimental Two-Wire 220-Volt Lighting System. Louis E. Foulks. Describes a plant located in New Egypt, N. J., lighting its streets and business buildings. 1300 w. Elec Wld—Oct. 22, 1898. No. 23429.

Potential.

The Drop of Potential at the Carbons of the Electric Arc. Mrs. Ayrton. Abstract of a paper read before the British Assn., Section A. An account of experiments made and results obtained. 1200 w. Elect'n, Lond—Sept. 23, 1898. No. 23124 A.

Ship Lighting.

Electrical Distribution on Board Ship. J. C. Bagot. Notes on methods used and precautions necessary. Ill. 1200 w. Elec Eng, Lond—Oct. 7, 1898. No. 23396 A.

Station Operation.

Methods of Operation and Distribution of an Electric Light Station. John W. Lieb. A lecture to the senior class of the Stevens Inst. Explains the methods employed at the Duane Street station of New York. 1500 w. Stevens Ind—Oct., 1898. No. 23651 D.

Torpedo Vessels.

Electric Light on Torpedo Vessels. B. Pontifex. Discusses the wiring, searchlights, fittings and other arrangements. Ill. 1800 w. Elec Eng, Lond—Oct. 7, 1898. No. 23397 A.

Victoria.

Hawthorn (Victoria) Electric Lighting Scheme. From a report of the Electric Lighting Committee of the city of Hawthorn, Victoria, describing the system. 1500 w. Elec Rev, Lond—Sept. 23, 1898. No. 23129 A.

Welsbach.

Welsbach's Electric Lamp. Discusses the materials of the new filaments and gives Dr. William H. Wahl's opinion. Thinks there is to be no great advancement in electric lighting because of this invention. 1200 w. Jour Gas Lgt—Sept. 20, 1898. No. 23100 A.

Wiring.

Interior Electric Wiring. H. N. Gardner. An article for the benefit of beginners but containing suggestions for even competent wiremen. 2700 w. W Elect'n—Oct. 8, 1898. No. 23258.

Wiring the New York State Capitol. Describes what is claimed to be the largest and most difficult contract for concealed work in a finished building ever executed in the United States. Ill. 1400 w. Elec Eng, N. Y.—Oct. 13, 1898. No. 23313.

POWER.

Alternators.

The Paralleling of Alternators. Edward P. Burch. Gives suggestions of two simple ways of connecting alternators in parallel. 700 w. Elec Wld—Oct. 8, 1898. No. 23243.

Central Station.

The Evolution in Central Station Practice. Charles F. Scott. Showing the development of the polyphase system, and its especial adaptability for the distribution of power from central stations; including numerous illustrations and diagrams. 3500 w. Engineering Magazine—Nov., 1898. No. 23598 B.

Core Distribution.

Air-Gap and Core Distribution. W. Elwell Goldsborough. This first paper deals with the magnetic flux and its effect upon the regulation and efficiency of dynamo electric machinery. Outlines a method of calculating field densities which has been used by the writer with success. 3200 w. Trans Am Inst of Elec Engs—Aug. and Sept., 1898. Serial. 1st part. No. 23-491 D.

Electric Boring.

A New Application of the Electric Arc. J. Foster Symes. Describes a method of boring the rivet holes in armor plates, welding, and other uses. 1200 w. Yale Sci M—Oct., 1898. No. 23708 C.

Electric Energy.

Electric Energy in Bulk. An editorial on the proposed changes in electric light and power stations in England and the economy sought. 2200 w. Engng—Oct. 7, 1898. No. 23415 A.

Electric Power.

Electric Current for Lighting and Power on the Midland Railway, and Driving Machinery Direct by Electric Motor without Shafting. W. E. Langdon. Paper read before the Institution of Mech. Engs., England. Detailed description of the installations, with output and costs. 3000 w. Elect'n, Lond—Sept. 30, 1898. No. 23271 A.

Electric Light and Power at the Hofors Ironworks, Sweden. Illustrated description of the plant. 1400 w. Elec Eng, Lond—Sept. 30, 1898. No. 23272 A.

Gasoline Plant.

Gasoline Pumping and Lighting Plant at La Fox, Ill. A plant installed by the C. & N. W. Ry. for supplying water for the tanks and lighting buildings and yard. Ill. 900 w. Ry & Engng Rev—Oct. 15, 1898. No. 23434.

Haulage.

Electric Canal Haulage. A. H. Allen. Read before the British Assn., at Bristol. Describes an adaptation of electrical traction to canal haulage, invented by Messrs. Thwait and Cawley. It can be applied without interfering with the use of horses. The barges are hauled by means of rope, and an aerial railway is provided for the motors. Ill. 2500 w. Elec Eng, Lond—Sept. 30, 1898. No. 23273 A.

Hydraulic Plant.

The Hydraulic Electric Plant on the Sihl, Switzerland. (Station Hydro Electrique de la Sihl, Suisse.) A description of the hydraulic plant recently completed, by which about 2000 h. p. of the Sihl above Zurich are utilized for lighting and power. A fall of over 200 feet is obtained by running a channel across a loop formed by the river. Details of the turbines and generators are given. 3000 w. 1 plate. Le Génie Civil—Oct. 8, 1898. No. 23506 D.

Isolated Plant.

Power Plant of the Chicago Public Library. Brief description, giving the boiler tests and engine tests. Ill. 2000 w. Engr, N. Y.—Oct. 15, 1898. No. 23444.

Lifts.

Electric Dumb Waiters in the Chicago Public Library. Illustrates and describes the arrangements for delivering books from one department to another in the building. 2000 w. Elec Eng, N. Y.—Oct. 6, 1898. No. 23229.

Tests of Electric Elevators. William S. Monroe. Gives data concerning the power used in starting and moving. 800 w. Eng Rec—Oct. 1 ,1898. No. 23159.

The Fraser Electric Elevator. A. E. Brooke Ridley. Briefly reviews various elevator systems, pointing out the disadvantages of each, and gives a somewhat detailed description of the invention of E. M. Fraser, which it claims, obviates most of the disadvantages mentioned. Also discussion. 8800 w. Jour Assn of Engng Soc's—Sept., 1898. No. 23706 C.

Power Station.

Colorado Electric Power Co.'s Station at Cañon City. Bert E. Wade. Illustrated detailed description of a plant designed to supply power and light to mines. 1200 w. Elec Eng, N. Y.—Oct. 20, 1898. No. 23440.

Test of the LaFayette, Ind., Street Railway Power Plant. G. W. Munro. Abstract of a thesis presented to the Faculty of Purdue Univ. Describes the plant and the conditions of schedule and grade, reporting the tests and results. Ill. 2000 w. St Ry Rev—Oct. 15, 1898. No. 23455 C.

The Generation of Electricity by Water Power at Mechanicsville, New York. An illustrated detailed description of a Hudson River power-plant which will supply Schenectady and other places in the vicinity. 3200 w. Power—Oct., 1898. No. 23228.

Regulation.

The Regulation of the Mechanical Plant. Brief description of this system for automatically regulating the voltage of power delivered.

An interesting application of various principles of alternate-current working. 1200 w. Elec Wld—Oct. 1, 1898. No. 23088.

Storage Batteries.

Electricity in Packages. E. Ralph Estep. Deals with the rapid development of the storage battery and the uses to which it is applied. Ill. 3500 w. Mod Mach—Oct., 1898. Serial. 1st part. No. 23435.

Tanning.

Tanning by Electricity. Describes and illustrates an important device of a Boston inventor which gives promise of causing great changes in this business. 1600 w. Bos Jour of Com—Oct. 22, 1898. No. 23480.

Transmission.

A French View of Electrical Power Transmission. Abstract of an interesting article in the *Revue Générale des Sciences*, by M. Paul Janet. Discusses the efficiency of transmission, and the systems employed. 2000 w. Elec Rev, Lond—Sept. 30, 1898. No. 23275 A.

On the Transmission of Power by Two- and Three-Phase Currents. Andrew Stewart. Considers the merits of the two systems. 1200 w. Elec, Lond—Oct. 14, 1898. No. 23482 A.

Tesla's System of Electric Power Transmission Through Natural Media. Illustrates and describes a novel method for the transmission of electrical energy without metallic line conductors. 2000 w. Elec Rev, N. Y.—Oct. 26, 1898. No. 23663.

The Transmission Plant of the Fries Manufacturing and Power Company. An illustrated description of a North Carolina plant. 2200 w. Am Elect'n—Oct., 1898. No. 23095.

Water Wheels.

Electric Transmission in California. Alfred Tregidgo. Illustrates and describes the Tutthill impulse water-wheels in course of erection at the San Gabriel Electric Co.'s Power Station, Azusa, Cal. 400 w. Min & Sci Pr—Oct. 15, 1898. No. 23470.

Wave Power.

The Utilization of Wave-Power. The investigations of B. Morley Fletcher, with illustrated account of a successful visit recently paid to Spanish waters to demonstrate further the value of his invention. Ill. 1800 w. Ind & Ir—Sept. 30, 1898. No. 23283 A.

TELEGRAPHY AND TELEPHONY.

Balloon Signalling.

The Use of Electric Balloon Signalling in Arctic and Antarctic Expeditions. Eric Bruce. Read before the British Assn. Describes a system invented by the author and adapted for war signalling purposes, and lately adapted to the wants of exploration. 800 w. Elec Eng, N. Y.—Oct. 20, 1898. No. 23442.

Cable Routes.

Side Lights on Cable Routes. Part first discusses proposals made by the Eastern, Eastern Extension, and Eastern and South African telegraph companies, to the Imperial Government. 2000 w. Elec Rev, Lond—Sept. 23, 1898. Serial. 1st part. No. 23128 A.

Disturbances.

Some Telephone Disturbances from Electrical Generators. George D. Shepardson. Reports a study of troubles in a western city, describing experiments made and conclusions reached. 6400 w. Trans Am Inst of Elec Engs—Aug. & Sept., 1898. No. 23490 D.

Exchange.

The New Telephone Exchange at Worcester, Mass. Describes a building built expressly for this purpose and equipped with the latest and most approved appliances. Ill. 1000 w. Elec Eng, N. Y.—Oct. 13, 1898. No. 23317.

Limiting Distance.

Limiting Distance of Telephone Speech and the K. R. Law. A. E. Dobbs. Discusses some points affecting the capacity of a line, showing that the limiting distance has not yet been found. 1600 w. Elec Eng, N. Y.—Oct. 27, 1898. No. 23660.

Pacific Cable.

An All-British, or Anglo-American, Pacific Cable. Charles Bright. Discusses the question of spanning the Pacific ocean, connecting with the British colonies, giving reasons in favor of All British lines, and also considering an alliance with the United States. Map. 3000 w. Fortnightly Rev—Sept., 1898. No. 23118 E.

On the Pacific Cable. Charles Bright. Read before the British Assn. for the Adv. of Science. A discussion of the main features of interest and importance, including the survey, type of cable, laying, repairing, electrical working. 4000 w. Elec Rev, Lond—Sept. 23, 1898. No. 23130 A.

Persia.

Telegraphs and Telephones in Persia. An account of the construction, systems in use, and progress. 800 w. Jour Soc of Arts—Oct. 14, 1898. No. 23484 A.

Space Telegraphy.

The Hertzian Telegraphy Without Wires. (La Télégraphie Hertzienne, sans Fil.) E. Ducretet. Containing numerous illustrations of the apparatus used in space telegraphy, and a general description of the method ; being an address before the International Society of Electricians. Two articles. 2500 w. Electricien—Oct. 8, 15, 1898. No. 23556 each B.

Telegraphy by Means of Ultra-Violet Light. Karl Zickler. Abstract of an article in the *Elektrotechnische Zeitschrift*. Describes apparatus used, experiments made and gives results obtained. 1800 w. Elect'n, Lond—Sept. 23, 1898. No. 23125 A.

Wireless Telegraph and Signal Co. (Limited). A report of the second general meeting with an interesting speech by H. J. Davis, chairman and managing director. Also editorial. 4500 w. Elect'n, Lond—Oct. 14, 1898. No. 23604 A.

Telephones.

The State and the Telephones ; the Story of a Betrayal of Public Interests. Robert Donald. Discusses matters brought to light by investigations of a select committee of the British House of Commons, and the solution of the difficulties. 7500 w. Contemporary Rev—Oct., 1898. No. 23370 D.

MISCELLANY.

Accumulators.

A Comparison Between Various Accumulators. (Ueber die Vergleichende Darstellung von Akkumulatoren.) P. Schoop & H. Benndorf. A detailed account of comparative tests. Very fully tabulated data are given, this instalment containing the results for the Baumgarten and the Gülcher accumulators. Serial. Part I. Elektrochemische Zeitschr—Oct., 1898. No. 23558 H.

The Action of Accumulators. (Die Wirkungsweise der Akkumulatoren.) Dr. F. Hoppe. A discussion of the chemical and physical actions involved in the operation of the electrical storage battery. 2000 w. Elektrotech Rundschau —Oct. 15, 1898. No. 23545 B.

Alternating Currents.

Alternating Currents. The first of a series of articles dealing with the phenomena, principles, and application of these currents. Ill. 3800 w. Ind & Ir—Sept. 30, 1898. Serial. 1st part. No. 23282 A.

A New Form of Alternating Current Instrument. Arthur C. Heap. Describes a method of construction designed by the writer to overcome sources of error in amperemeters and voltmeters. Ill. 800 w. Elec Rev, Lond—Sept. 23, 1898. No. 23127 A.

Ampere.

Redetermination of the Ampere. Report of the committee on Standards of Measurement to the Am. Assn. for the Adv. of Science. 700 w. Elec Rev, N. Y.—Oct. 5, 1898. No. 23119.

Capacity.

Electrostatic Capacity of Wires. W. Moon. Mathematical demonstration. 800 w. Elec Rev, Lond—Sept. 30, 1898. No. 23277 A.

Commutators.

Devices for Exploring the Potential Around Commutators. George D. Shepardson. Describes methods and simple devices for various investigations. 1600 w. Am Elect'n—Oct., 1898. No. 23096.

Conduits.

Two Draw-In Conduits Under Boston Rivers. Illustrated detailed description. 1300 w. Elec Wld—Oct. 29, 1898. No. 23665.

Currents.

Currents in Branched and in Mutually Inducing Circuits Produced by Harmonically Varying Electromotive Forces. Thomas R. Lyle. The first of a series of articles in which the writer aims to reduce the currents named to something of the simplicity of the theory of steady currents in branched conductors. 1500 w. Elect'n, Lond—Oct. 14, 1898. Serial. 1st part. No. 23605 A.

Duality.

The Duality between Electrical and Magnetic Phenomena. (Die Dualität zwischen Elektrischen und Magnetischen Erscheinung.) W. Weiler. A geometric discussion showing the accordance of electrical and magnetic phenomena with the deductions of the modern geometry of position. 2000 w. Elektrotech Rundschau—Oct. 1, 1898. No. 23544 B.

Earth Currents.

Short Method of Correcting Schaefer's Break Test for Earth Currents. Walter J. Murphy. Rules enabling observers to calculate rapidly, or estimate mentally, the influence of the E. C. upon results obtained by Schaefer's method of localizing breaks in submarine cables. 500 w. Elect'n, Lond—Sept. 23, 1898. No. 23122 A.

High Temperatures.

The Chemistry of High Temperatures. An outline of the researches of M. Henri Moissan for which he has been awarded a Franklin Institute medal. 1200 w. Bos Jour of Com—Oct. 8, 1898. No. 23253.

Hysteresis.

Magnetic Hysteresis and Eddy Currents. (Magnetische Hysteresis und Wirbelströme.) F. Niethammer. A discussion of the methods of determining the magnetic coefficients for various kinds of magnetization; with curves plotted from the results. Two articles. 6000 w. Elektrotech Zeitschr—Oct. 6, 13, 1898. No. 23552 each B.

Jacques Process.

The Jacques Process for Converting Heat into Electricity. Abstract of a paper read by Prof. Langley before the Electric Club of Cleveland. Shows that Dr. Jacques' electric generator is an ordinary thermo-electric battery. Ill. 1700 w. Eng News—Sept. 29, 1898. No. 23074.

Magnetism.

Magnetism. Forée Bain. Suggestions gained by practical observation. 1800 w. W Elect'n —Oct. 8, 1898. No. 23259.

Measurements.

Methods of Using a Wattmeter, a Voltmeter, and an Ammeter. Frederick Bedell. Gives four methods for connecting and reading the instruments. 1200 w. Sib Jour of Engng—Oct., 1898. No. 23473 C.

Simple Volt-, Ampere-, and Wattmeters. Charles T. Child. Illustrates and describes several forms of such instruments that can be easily made by the amateur, at small cost. 2500 w. Am Elect'n—Oct., 1898. Serial. 1st part. No. 23097.

The Construction and Use of Simple Electrical Measuring Apparatus. Howard B. Little. Describes instruments that may be made by electricians with which they can undertake research work. Part first describes the tangent galvanometer. 1800 w. Elec, Lond—Sept. 30, 1898. Serial. 1st part. No. 23262 A.

The Measurement of High Electric Voltages. (Ueber die Messung Hoher Elektrischer Spannungen.) W. Peukert. A method of measuring high voltages by means of condensers in a portion of the circuit, instead of measuring the potential at the terminals. 2000 w. Elektrotech Zeitschr—Sept. 29, 1898. No. 23548 B.

See Street and Electric Tramways.

Plants.

The Action of Electricity on Plants. E. H. Cook. Abstract of a paper read before the

British Assn. Deals with its influence on seed germination, growing plants, &c. 2000 w. Elect'n, Lond—Oct. 7, 1898. No. 23422 A.

Radiography.

Progress in the Technics of Röntgen Rays. (Fortschritte der Röntgentechnik.) Max Levy. A discussion of the theory of the production of Röntgen rays, and a description of the best apparatus for the purpose. 4000 w. Elektrotech Zeitschr—Sept. 22, 1898. No. 23547 B.

Speculations Concerning Roentgen Rays. Francke L. Woodward. A brief statement of things noticed during the writer's researches, with suggestion of a possible explanation. 900 w. Elec Eng, N. Y.—Oct. 13, 1898. No. 23318.

X-Ray Work in Baltimore. C. B. Fairchild. Reports the work in Loyola College, University Hospital and Johns Hopkins Hospital. 2000 w. Elec Eng, N. Y.—Oct. 6, 1898. No. 23231.

Refrigeration.

Electrical Refrigeration. Thomas J. Fay. Describes a system where electricity is used as a motive power, and a compressor, driven by an electric motor, compresses a refrigerating medium. Ill. 1500 w. Elec Eng, N. Y.—Oct. 6, 1898. No. 23230.

Screens.

Applications of Electro-Magnetic Screens. (Applications des Ecrans Electromagnetiques.) A discussion of the effects of screens of magnetic metals in various applications, showing the agreement of practical results with those indicated by theory. Two articles. 2500 w. Electricien—Oct. 8, 15, 1898. No. 23557 each B.

Temperature Coefficients.

On the Determination of the Temperature Coefficients of Two 10-Ohm Standard Resistance Coils (Nos. 3,873 and 3,874) Used in the 1897 Determination of the Ohm. M. Solomon. Read before the British Assn. The results of tests made on the two 10-ohm coils to make as accurate a determination as possible of the values for the coefficients. Ill. 2000 w. Elect'n, Lond—Sept. 23, 1898. No. 23123 A.

Transformers.

Transformer Regulation. Frederick Bedell. An explanation of a simple working formula for determining the regulation drop in lighting and power transformers. 900 w. Elec Wld—Oct. 8, 1898. No. 23241.

Zeeman Effect.

Preston's Investigations on the Zeeman Effect. Study of the effect on the bright lines of the spectrum when placed in a strong magnetic field. 1400 w. Elec Rev, Lond—Oct. 7, 1898. Serial. 1st part. No. 23423 A.

MARINE ENGINEERING.

American Steamers.

American Paddle-Wheel Steamers with Beam Engines. Particulars and description of the engines and steamers used so extensively for inland navigation in the United States. 2500 w. Engr, Lond—Sept. 23, 1898. Serial. 2 parts. No. 23141 each A.

Buoys.

Electric Gong Buoys—Audible versus Visual Signals. F. A. Hamilton. Read at convention of the Maritime Electrical Assn. Illustrated description of a system for utilizing electricity for facilitating navigation, explaining the details of the proposed method. 2400 w. Can Elec News—Oct., 1898. No. 23307.

Gondola.

The Gondola : Its History and Manufacture. Condensed from an account by Horatio F. Brown. Interesting information relating to the changes, use and making of these boats of Venice. 1800 w. Sci Am—Oct. 15, 1898. No. 23345.

Ocean Liners.

The Latest Union Liner. Descriptive and illustrated account of the latest addition to the Union Steamship Company's fleet, the twin-screw R. M. S. Briton. 1200 w. Transport —Sept. 30, 1898. No. 23269 A.

Pilot Boats.

The Pilots and Pilot Boats of New York. Gives the history of this service and outlines the changes that have added to the comfort and lessened the peril of the pilot's life. Ill. 1800 w. Sci Am—Oct. 22, 1898. No. 23464.

Propeller.

The Screw Propeller, with Some Notes on the Geometry of the Subject. Part first gives definitions of terms used and refers to the conditions that determine the dimensions and performance generally. 2000 w. Prac Eng—Oct. 7, 1898. Serial. 1st part. No. 23421 A.

Propulsion.

Discussion of Some Theories of Steamship Propulsion. Robert Mansel. Discusses the theories of M. Dupuy de Lome, Rankine and others, showing discrepancies. 2700 w. Engr, Lond—Oct. 14. 1898. No. 23610 A.

The Turbine for Naval Propulsion. Discusses the great speed that has been attained, the probability of the turbine soon replacing the steam engine for marine propulsion, and the defects to be overcome before it can be used on shore. 800 w. Bos Jour of Com—Oct. 22, 1898. No. 23481.

Revenue Cutter.

Machinery for the New Revenue Cutter to be Stationed at New York. Illustrations showing the designs of the engines and boilers of the boat known officially as No. 6, now being built at Baltimore. 700 w. Marine Engng—Oct., 1898. No. 23191 C.

Roller Boat.

Construction and Details of the Knapp Roller Boat. Illustrates and describes the boat, and discusses its operation. 900 w. Sci Am—Oct. 8, 1898. No. 23235.

Shipbuilding.

The Steel Foundations of the Shipbuilding Industry. A review of the transformations which have taken place in the use of steel as a marine structural material, with especial reference to the use of ferro-manganese. 2500 w. Engineering Magazine—Nov., 1898. No. 23591 B.

Ship Lighting.

See Electrical Engineering, Lighting.

Shipping.

See Economics and Industry, Commerce.

Steamers.

The Latest Additions to the Castle Line to the Cape. Illustrated description of two steamers to be used on the route between England and South Africa. 2500 w. Steamship—Oct., 1898. No. 23193 A.

Submarine Boats.

Submarine Boats. George N. Crouse. Reviews the history of the attempts at submarine navigation, and the degree of success recently attained. 3000 w. Yale Sci M—Oct., 1898. No. 23709 C.

Yacht.

U. S. S. Sylph, Selected by the Navy Department as the President's Yacht. Illustrated detailed description. 1200 w. Marine Engng—Oct., 1898. No. 23189 C.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Plant.

See Mining and Metallurgy, Coal and Coke.

Boiler Plates.

On the Thermal Condition of Iron, Steel and Copper When Acting on Boiler Plates. Ella Mary Bryant. Illustrates and describes investigations made to determine the temperature of boiler plates. The measurements were made by thermo-electric junctions embedded in the substance of the plate. 900 w. Prac Eng—Sept. 23, 1898. Serial. 1st part. No 23217 A.

Boiler Selection.

The Choice of a Boiler. Discusses some of the points of first importance to be considered. 1700 w. Engng Mech—Oct., 1898. No. 23662 C.

Boiler Specifications.

Report of Committee on Uniform American Boiler Specifications. The report as finally adopted at the convention of American Boiler Manufacturers Assn. at St. Louis. 4500 w. Ir Age—Oct. 13, 1898. No. 23322.

Boiler Waters.

A Scheme for the Rapid Analysis of Boiler Waters for Scale-forming Ingredients. Thomas B. Stillman. Gives a scheme of analysis used by the author which shows many advantages for correct determinations with rapidity. 600 w. Stevens Ind—Oct., 1898. No. 23647 D.

Cleaning.

Cleaning Boilers. A device, patented by John Stephenson, of Newark, N. J., which permits automatically cleaning the top surface of all tubes 450 w. Bos Jour of Com—Oct. 1, 1898. No. 23152.

Coverings.

Coverings for Locomotive Boilers. Editorial report of tests being conducted by Charles L. Norton, at the Mass. Inst. of Technology, with statement of facts from reports of tests previously made. 1600 w. R R Gaz—Sept. 30, 1898. No. 23082.

The Protection of Steam-Heated Surfaces. Charles L. Norton. A partial report of investigations still in progress, with illustrated description of method of testing, apparatus used, &c. The relative efficiency of different coverings, the fire risks in certain methods and materials, and the gain in economy are studied. 4000 w. Tech Quar—Sept., 1898. No. 23201 F.

Evaporation.

The Evaporation of Steam in Boilers. A comparison with nature's process in the evaporation of the dew. 1800 w. Bos Jour of Com—Sept. 24, 1893. No. 23046.

The Relation of Rate of Evaporation to Efficiency of Steam Boilers. George R. Bale. Showing that boilers of all types give practically identical efficiency at any given rate of evaporation, when worked under conditions most suitable to the particular description of the fuel employed. 2500 w. Prac Eng—Sept. 23, 1898. No. 23218 A.

Explosions.

The Boiler Explosions in Germany in the Year 1897. (Die Dampfkesselexplosionen in Deutschen Reiche im Jahre 1897.) A tabulated report with notes giving the ascertainable facts and details of the boiler explosions in the German empire for 1897, with notes and comments Two articles. 7000 w. Zeitschr d Ver Deutscher Ing—Sept. 24, 1898. No. 23527 each D.

Flues.

Strength of Internal Flues. From the Annual Report of the Engine Boiler and Employers-Liability Insurance Company, Limited (England). Describes experiments on a Lancashire boiler, giving inferences drawn. 700 w. Mech Wld—Sept. 16, 1898. No. 23042 A.

Incrustation.

The Prevention and Removal of Boiler Scale. (Verhinderung und Beseitigung des Kesselsteines.) R. Danilof. A discussion of the various chemical and mechanical methods of preventing and removing incrustations, calling especial attention to the use of cold water for loosening scale. 2000 w. Oesterr Zeitschr f Berg u Huttenwesen—Sept. 24, 1898. No. 23573 B.

Mining Boilers.

Steam Boilers for Mining Purposes. William

Kent. The principles governing their economical and efficient use. The influence of local conditions on the size and type of boilers, and an impartial study of best types for varying conditions. 1500 w. Mines & Min—Oct., 1898. No. 23175 C.

Oil Filters.

The Removal of Oil from Feed Water. Editorial statement of the value of oil filters for condensing engine plants or systems where exhaust-steam heating is practiced. 900 w. Eng Rec—Oct. 29, 1898. No. 23692.

Smoke Prevention.

Coal Combustion and Smoke Prevention. John L. Howard. Read before the sixth annual meeting of the Pacific Coast Gas Assn., San Francisco. Considers the character and composition of fuels and the conditions that favor complete combustion. 2600 w. Jour of Elec—Sept., 1898. No. 23638.

Smoke Prevention. W. H. Booth. States the conditions causing smoke and the means of controlling the difficulty. 1800 w. Am Mach—Sept. 29, 1898. No. 23107.

The Orvis Smoke Prevention Apparatus. (Appareil Fumivore Orvis.) An illustrated account of one of the furnaces which received honorable mention at the recent tests in Paris. Steam jets are used to deliver air blasts above the grate. 1200 w. Electricien—Sept. 24, 1898. No. 23553 B.

Test Meters.

Test Meters for Boiler Plants. Lehman B. Hoit. Showing the value of the Worthington Test Meter. Ill. and discussion. 3300 w. Jour Assn of Engng Soc's—Sept., 1898. No. 23707 C.

Tubes.

The Grooving of Tube Ends. The cause of this tube-destruction, method of repairing and cure. Ill. 1800 w. Locomotive—Sept., 1898. No. 23632.

Water-Tubes.

Water-Tube Boilers for Utilizing Blast Furnace Gas and Waste Heat. J. H. Ashby. Abstract of paper read at meeting of Cleveland Inst. of Engs., England. The advantages of the Babcock and Wilcox boiler are stated, the arrangement, reheating, &c., are considered. 1800 w. Col Guard—Oct. 7, 1898. No. 23409 A.

COMPRESSED AIR.

Air-Compressing Plant.

Test of a Modern Air-Compressing Plant at the Long Tunnel Gold Mine, Walhalla. E. J. Rigby. Gives results of a test for economy and efficiency, and shows that large savings may be effected by a proper use of the air after compression. Ill. 4400 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23392 G.

Air Lifts.

The Air Lift. Translation of paper by E. Josse, in the *Zeitschrift des Vereines Deutscher Ingenieure*. Gives description of several German plants and the results of tests made on them. 3000 w. Eng Rec—Oct. 8 and 15, 1898. Serial, 2 parts. No. 23183.

Compressor.

A Gasoline Air Compressor for Bridge Work. Illustrates and describes a portable plant for generating compressed air, used in connection with work at West Point, Ky., in strengthening a bridge on the Illinois Central railroad. 1100 w. Ry Age—Oct. 14, 1898. No. 23437.

Efficiency.

What is the Efficiency of an Air Compressor? Frank Richards. A discussion of the subject of compression, showing the fallacy of some ideas generally held. 1400 w. Am Mach—Oct. 6, 1898. No. 23265.

Pneumatic Tools.

A Pneumatic Car Journal Turner. Illustrates and describes a machine that enables car journals to be turned on the repair tracks. 400 w. R R Gaz—Oct. 14, 1898. No. 23343.

Boyer's Pneumatic Drill. Illustrated description of a light, easily handled machine, very powerful for its size, and not liable to get out of order. 4000 w. Engng—Sept. 23, 1898. No. 23145 A.

Tamping.

See Railway Affairs, Permanent Way.

ENGINES AND MOTORS.

Balancing.

The Balancing of Multiple-Cylinder Marine Engines. (Ausbalanzirung Mehrcylindriger Schiffskraftmaschinen.) The full text of the judicial opinion of the Imperial Court upon the limitations of the Schlick system of balancing engines and reducing vibration, in the case of the Vulcan works against Schichau. An interesting and important review of the work of Taylor, Yarrow, Schlick and others. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 17, 1898. No. 23522 D.

Compression.

Cushion vs. Compression. W. H. Wakeman. A brief review of the meaning of the terms is given, pointing out the way to tell the difference on an indicator diagram, and discussion of the subject. 2500 w. Engr, U. S. A.—Oct. 1, 1898. No. 23198.

Condensation.

The Law of Condensation of Steam. Illustrated review of Callender and Nicolson's experiments and their results. 2000 w. Eng Rec—Oct. 22, 1898. No. 23628.

Cooling Reservoirs.

Cooling Reservoirs for Condensing Engines. Harold Wood Barker. From Excerpt Minutes of *Proceedings of the Institution of Civil Engineers*. Illustrates and describes the methods of construction usually adopted when means of storing and cooling are necessary, and considers the size necessary for any given power. 2300 w. Prac Eng—Sept. 23, 1898. Serial. 1st part. No. 23219 A.

Diesel Motor.

Diesel's Rational Heat Motor. E. D. Meier. Introductory review of progress leading to this latest development in engine construction, with an account of the inventor and his work, a description ot the invention and its operation. Ill. 8800 w. Jour Fr Inst—Oct., 1898. No. 23202 D.

Gas Engines.

Gas Producers and the Future of the Gas Engine. A. Bement, in *Modern Machinery*. Discusses the methods being tried in Europe for utilizing blast-furnace gases, the use of water gas, &c. 2300 w. Pro Age—Oct. 1, 1898. No. 23109.

Oil and Gas Engines. James D. Roots. States the lines on which he considers future improvements will be made, and gives an account of experiments and conclusions drawn. 8800 w. Engng Mech—Sept., 1898. No. 23050 C.

The Benier Gas Engine and Producer. Describes an engine and generator which have been proved to do their work satisfactorily. Ill. 1700 w. Engng—Sept. 23, 1898. No. 23144 A.

The Kelly-Kelch Gas Engine. Illustrated description of what is claimed to be something new in this line. 700 w. Am Mfr & Ir Wld—Oct. 7, 1898. No. 23310.

The Thermal Cycle of the Gas Engine. (Die Kreisprozesse der Gasmaschine.) A. Stodola. A very full thermodynamic study of the action of the gas engine, including the Diesel motor, showing the practical application of the entropy diagram. An important paper. Two articles. 10,000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Sept. 17, 24, 1898. No. 23521 each D.

See Municipal Engineering, Water Supply.

Gasoline Motor.

Improved Gasoline Motor. (Nouveau Moteur à Essence de Pétrole.) An illustrated description of the Bidaud motor, well adapted for use on automobiles. 1000 w. Le Génie Civil—Oct. 1, 1898. No. 23505 D.

Motive-Power Machines.

Engines and Pumps for Water, Sewage, and Irrigation Works. Philip R. Bjorling. Part first consists of introductory remarks and commences the description of suitable plants of each class for countries like India and the East. 1600 w. Ind & East Engr—Sept., 1898. Serial. 1st part. No. 23407 D.

Packing.

Packings for Pistons and Valves. (Garnitures de Pistons et de Tiroirs) M. Haas. Discussing especially piston packings for marine engines operating with high-pressure steam, with many illustrations of actual packings. 3500 w. Revue de Mechanique—Sept., 1898. No. 23537 H.

Pumping Engine.

The Hydraulic Service Engine of the Pope Tube Company. Illustrates and describes a crank machine operating under pressure of 1200 pounds and over per square inch, and running with complete absence of shock at sixty turns per minute. 1000 w. Am Mach—Oct. 20, 1898 Serial. 1st part. No. 23445.

The Kley Steam Pumping Engine for Mine Drainage. (Die Kley'sche Wasserhaltungs-Dampfmaschinenanlage.) Carl Habermann. A description of the compound mining pump used at the Idria Mines, with details of construction and data and results of test. Three articles. 12,000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—Sept. 23, 30, Oct. 7, 1898. No. 23519 each B.

Reversing Engine.

Tandem Reversing Engine. (Tandem Reversirmaschine.) C. Kiesselbach. Describing and illustrating a double tandem compound reversing rolling mill engine constructed for the Hernádthaler Iron Works, Krompach, Hungary. 1500 w. 1 plate. Stahl und Eisen—Sept. 15, 1898. No. 23561 D.

Steam Engineers.

Should a Steam Engineer Be a Machinist? H. H. Kelley. A discussion of this question with the writer's views. 2000 w. Engr, N. Y. Sept. 15, 1898. No. 23061.

Steam Turbine.

The Influence of the Motion of a Ship upon the Flexible Shaft of the de Laval Steam Turbine. (Die Beanspruchung der Federn Ochse der de Lavalschen Dampfturbine in folge von Schwankungen bei Aufstellung in Schiffen.) A. Böttcher. Showing the effect of gyroscopic action, and demonstrating that the effect of the ship's motion is but slight. 2000 w. Zeitschr d Ver Deutscher Ing—Oct. 8, 1898. No. 23532 D.

Willans Engine.

The Willans Central Valve Engine. Illustrates and describes this high-speed engine, with report of tests. 2200 w. Eng & Min Jour—Oct. 1, 1898. No. 23101.

POWER AND TRANSMISSION.

Exposition.

The Universal Exposition of 1900. (Exposition Universelle de 1900.) The official specifications for the steam and electrical power plant, including the concessions to exhibitors for furnishing power. 4500 w. La Revue Technique—Sept. 25, 1898. No. 23511 D.

Installation.

Essential Principles of Economy in Steam Power Installation. W. Cooper. Showing economy of a well designed steam plant as compared with one which has been installed without due system and judgment. 4000 w. Engineering Magazine—Nov., 1898. No. 23593 B.

Power Gage.

A Direct-Reading Power Gage for Steam Engines. Illustrates and describes an invention of G. F. Atwood, which is a radical departure, employing an entirely new principle for the measurement of the pressure in the cylinder. 1200 w. Eng News—Oct. 20, 1898. No. 23460.

Power Plants.

Power Plant Arithmetic. W. H. Wakeman. The first of a series of articles aiming to give needed enlightenment to the men who operate power plants. 1800 w. Engr, U. S. A., Sept. 15, 1898. Serial. 1st part. No. 23062.

Rope Driving.

Ropes and Rope Driving. L. H. Kenyon.

Read before the Manchester Assn. of Engs. Brief review of the history of rope driving with discussion of methods and the means of securing the best results. 1500 w. Can Eng—Oct., 1898. Serial. 1st part. No. 23303.

Water Wheels.

Graphics of Water Wheels. William Fox. Showing the superiority of the graphical method to the analytical in the discussion of the involved problem of turbines and other water-wheels. 2500 w. Stevens Ind—Oct., 1898. No. 23650 D.

SHOP AND FOUNDRY.

Annealing.

Annealing and Casehardening. Joseph Horner. The first of a series of articles giving an account of the processes, furnaces, &c., employed in the work of annealing cast iron and of case-hardening malleable iron. Ill. 1800 w. Mech Wld—Oct. 14, 1898. Serial. 1st part. No. 23498 A.

Ball Bearing.

A Ball Bearing Experience. C. P. Benns. Describes an arrangement including balls which cannot possibly roll, and investigates the two-point bearing and the three point bearing. Ill. 1600 w. Am Mach—Oct. 13, 1898. No. 23328.

Castings.

Reuniting Broken Iron Castings. Thomas F. Kennedy. Describes this method of repairing, and calls attention to points requiring special care. 1500 w. Met Work—Oct. 29, 1898. No. 23698.

Cast Iron.

Malleable Cast Iron. George C. Davis. Read before the Philadelphia Foundrymen's Assn. Gives its early history in the United States. 5500 w. Ir Age—Oct. 13, 1898. No. 23324.

The Melting Point of Cast Iron. Dr. R. Moldenke. Read before the Pittsburg Foundrymen's Assn. Describes and illustrates the Le Chatelier pyrometer modified for determining melting temperatures of cast iron, giving results obtained, and general observations. 2000 w. Ir Age—Oct. 20, 1898. No. 23439.

The Record of Seth Boyden's Experiments on Malleable Cast Iron. The first publication of Boyden's original manuscript. 10,000 w. Ir Age—Oct. 13, 1898 No. 23323.

Cone Pulleys.

Proportioning Cone Pulleys. John E. Sweet. Presents the writer's method, of value to all who deal with cone pulley design. Diagrams. 1500 w. Am Mach—Oct. 13, 1898. No. 23329.

Coremakers.

Girls as Coremakers. R. H. Palmer. An account of visits to several foundries where girls are employed, showing that it is a line of work that girls can use in making their living. 1800 w. Foundry—Oct., 1898 No. 23432.

Cost Keeping.

Cost Keeping and Accounting. W. S. Rogers. A paper, with discussion, before the N. Y. R. R. Club, giving methods used by the writer. 7500 w. N Y R R Club—Sept 15, 1898. No. 23398.

Effective Systems of Finding and Keeping Shop Costs. Henry Roland. A discussion of the various methods of determining and apportioning the expense account, including the relations of productive labor to general expense. 8500 w. Engineering Magazine—Nov., 1898. No. 23594 B.

Cupola Practice.

Modern Cupola Practice and the Physics of Cast Iron. Bertrand S. Summers. Condensed from a paper presented at the Am. Inst. of Min. Engs. Briefly considers the separate elements and their effects; examines tabulated analyses of various castings, and discusses other influences. 3800 w. Eng News—Oct. 6, 1898. No. 23247.

Drilling.

Nieustaedt's Improvements in Drilling Machines. From the *English Mechanic*. Illustrated description of mechanism for controlling the velocity in drilling. 1000 w. Prac Eng—Sept. 30, 1898. No. 23266 A.

Erection.

The Erection of a Locomotive in 66 hours. (Montage de Locomotive Exécuté en 66 Heures.) Describing this rapid piece of erection work in the Epernay works of the Eastern Railway of France. Several views are given showing successive stages of the work. 1000 w. Le Génie Civil—Oct. 1, 1898. No. 23504 D.

Gages.

Fitting Crown Brasses into Driving Boxes. Illustrated description of gages and method of using. 400 w. Am Mach—Oct. 20, 1898. No. 23447.

Gears.

An Odd Gear Pattern. John M. Richardson. Describes a pattern for a gear, made by the writer, used on a special machine for wrapping paper about oranges. 400 w. Am Mach—Oct. 20, 1898. No. 23446.

Suggestions on the Design of Corliss Valve Gears. John H. Barr. The paper explains certain expedients which have been found helpful in reaching a fairly satisfactory solution by trial on the drawing board. Gives method of determining the angle of advance of the eccentric, and method of projection directly from the virtual eccentric. Ill. 3300 w. Sib Jour of Engng—Oct., 1898. No. 23472 C.

Hardening.

Continuous Heating Machine for Hardening Small Articles. Illustrated description of a machine designed for hardening quantities of bicycle balls, but also useful in hardening other work not exceeding 2½ in. in any dimension. 700 w. Ir Age—Sept. 29, 1898. No. 23069.

Nurnberg Works.

The Elektricitäts-Actiengesellschaft, Late Schnekert and Co., Nürnberg, Germany. Illustrated description of these works and their equipment, with history of the founder, Siegmund Schuckert. 2500 w. Engng—Oct. 14, 1898. Serial. Part I. No. 23616 A.

Pattern Work.

Pattern Work that Helps the Molder. John

M. Richardson. Calls attention to points in the making and use of patterns which cause annoyance to the molder. 1500 w. Am Mach—Sept. 29, 1898. No. 23105.

Screw Machine.

The Spencer Automatic Screw Machine. Illustrated description of a machine designed for making all kinds of screws and studs, and also for cross-drilling pins and other parts for cycle and electric work. 2000 w. Engng—Sept. 30, 1898. No. 23295 A.

Steam Loop.

The Steam Loop. James Mackay. Illustrated description of this device and its operation. 1000 w. Dom Engng—Sept., 1898. No. 23058 C.

Turning Tool.

A Bezel Turning Tool. A. H. Cleaves. Illustrates and describes a tool of the writer's design used for turning down the rim of a brass bezel for holding a glass over a paper dial in one of the old watch style of cyclometers, and is recommended for similar work. 500 w. Am Mach—Oct. 13, 1898. No. 23330.

Type-Casting.

Rotary Type-Casting Machine. Illustrated description of the Wicks machine. 1400 w. Engr, Lond—Oct. 14, 1898. No. 23611 A.

Welding.

Welding of Metals. F. V. McMullin. A general discussion of the usefulness of this property and the methods used. 1600 w. Min & Sci Pr—Oct. 8, 1898. No. 23363.

Wire.

The Manufacture and Treatment of Wire for Electrical Purposes. J. Wright. Describes the various processes and treatments involved in the manufacture of wire from the raw material. 3800 w. Ind & East Engr—Sept., 1898. No. 23406 D.

MISCELLANY.

Automobiles.

A Steam Road Carriage. R. I. Clegg. Illustrates and describes an experimental steam carriage having interesting features, particularly in methods devised to secure automatic regulation of the fuel, steam pressure and water supply. 800 w. Am Mach—Oct. 6, 1898. No. 23264.

The Automobile Association (Limited). Illustrates and describes the more important vehicles in the collection of this company in England. They propose to supply all makes of moto-vehicles, including the best English and French types. 3800 w. Automotor Jour—Sept., 1898. No. 23040 A.

The Electric Vehicle Company. Outlines the problem of mechanical vehicles for street use, and the work undertaken by the company named. Ill. 2500 w. Am Mach--Sept. 29, 1898. No. 23104.

The Motor Carriage Industry. A review of the growth of this industry in various countries with an account of its present standing. Ill. 2000 w. Can Eng—Oct., 1898. No. 23299 A.

The R. A. S. E. Trials of Self-Moving Vehicles at Birmingham. Abstract of report of judges, signed by W. C. Unwin, and published in the Journal of the Royal Agricultural Society. 2000 w. Ind & Ir--Oct. 7, 1898. Serial. 1st part. No. 23413 A.

The Toward Steam Moto-Tractor. An official description with illustrations. 1200 w. Automotor Jour—Sept., 1898. No. 23041 A.

Cableway.

Building the Tramway Over Chilkoot Pass. W A. Burkholder. States the conditions under which this aerial tramway was constructed, giving illustrated description of the D.-K. T. Co.'s tramway. 1500 w. Jour of Elec—Sept., 1898. No. 23637.

Chili.

Metallurgy in Chili. Henry Watson. Part first discusses the rich mineral deposits, value of the ores, sources of ore supply, sampling, treatment, kilns, smelting, &c. Aust Min Stand—Sept. 8, 1898. Serial. 1st part. No. 23332 B.

Design.

Influence of Natural Forms on Mechanical Design. W. H. Sargent. Notes some of the forms in nature that have been applied to mechanics. Ill. 600 w. Am Mach—Sept. 29, 1898. No. 23106.

Exhaust Steam.

Heating Value of Exhaust Steam. E. P. Roberts and I. H. Sherwood. Discusses the uses of exhaust steam, giving table of the properties of saturated steam, and showing the loss of its heating value to be a large waste. Ill. 2000 w. Engr, U. S. A.—Sept. 15, 1898. No. 23060.

Exposition.

The Mechanical Plant of the Universal Exposition of 1900. (Le Service des Installations Mécaniques à l'Exposition Universelle de 1900.) Ch. Dantin. Showing the present condition of work on the Champ-de-Mars and describing the manner in which the boilers, engines, electric generators and piping of the exposition power plant are to be installed. 3000 w. 1 plate. Le Génie Civil—Oct. 1, 1898. No. 23502 D.

Farm Machinery.

California Harvesting Machinery. Frank Corry. Illustrates and describes the Laufenberg traction engine and combined harvester as used on the Pacific coast. 500 w. Sci Am—Oct. 8, 1898. No. 23236.

Ladder.

A Peculiar Style of Ladder. Gives a description of the ladder and its operation. Ill. 1000 w. Sci Am Sup—Oct. 8, 1898. No. 23238.

Lock Nut.

The Dickertmann Conical Lock Nut. (Die Konische Sicherheitsmutter, Patent Dickertmann.) An ingenious form of lock nut in which the locking is accomplished by forcing a conical projection on the end of the nut into the bolt hole. 1800 w. Glaser's Annalen—Oct. 1, 1898. No. 23542 D.

Lubrication.

Lubrication and the Testing of Oil. G. W. Bissell. Discusses the judicious selection and application of the lubricants. Part first deals largely with the properties. 2200 w. St Ry Rev—Oct. 15, 1898. No. 23456 C.

Lubrication. From the *Engineer's Mag.* Discusses the various oils and other products used for this purpose, and means of testing. 2500 w. Mech Wld—Oct. 14, 1898. No. 23-499 A.

The Testing of Lubricating Oils. (Die Prüfung der Maschinen-Schmieröle.) Carl Volk. showing the great reduction in friction by using Suitable lubricants, and dealing with methods of testing for viscosity and the detection of impurities. 1600 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 24, 1898. No. 23572 B.

Prony Brake.

Improved Spring Balance for Testing Electric Motors with the Prony Brake. (Verbesserte Federwaage für Bremsungen von Elektromotoren mit dem Prony'schen Zaum.) A. Wettler. A simple and delicate arrangement by which readings may easily be made, and power accurately computed. Full details of the apparatus are given. 1800 w. Elektrotech Zeitschr—Sept. 29, 1898. No. 23549 B.

Pump Test.

Test of a Snow Pump at Indianapolis. Report of trial of a 20,000,000-gal. triple-expansion pump giving 150,100,000-ft.-lbs. per million heat units supplied. 1300 w. Eng Rec—Oct. 15, 1898. No. 23359.

Pyrometers.

Metal Pyrometers. J. H. Kinealy. Considers the principles on which they operate and the care and skill needed to obtain reliable results. Ill. 1400 w. Mod Mach—Oct., 1898. No. 23436.

Refrigeration.

Mechanical Refrigeration. Peter Neff, Jr. A simple explanation of the principles of mechanical refrigeration. 1100 w. Engr, U. S. A. —Sept., 15, 1898. Serial. 1st part. No. 23-064.

The Importance of Water for Refrigerating Machines. Alfred Siebert. Considers different types of refrigerating machines, showing how indispensable is water, the best method of expelling air, &c. 2500 w. Ice & Refrig—Oct., 1898. No. 23226 C.

Steam Cutting.

Cutting by Steam. James P. Hobart. Shows that pure steam does not cut, but that the action is produced by other substances carried by the steam. Cites examples. Ill. 1500 w. Am Elect'n—Oct., 1898. No. 23099.

Textile Machinery.

Improved Textile Machinery. (Neuerungen an Arbeitsmaschinen für die Textilindustrie.) G. Rohn. Illustrating and describing recent improved cotton spinning machinery used in the mills in Saxony. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 8, 1898. No. 23531 D.

Thermal Efficiency.

Losses of Heat in a Steam Plant. Gives a diagram reproduced from the report recently issued by a committee of the Institution of Civil Engineers. It was made by Capt. Sankey, and shows the various heat losses in a real and an ideal steam plant. Also a summary of the recommendations of the committee. 3000 w. Eng News—Oct. 20, 1898. No. 23462.

Thermometer.

A Giant Thermometer. An account of a large thermometer being made in England to register the earth's heat. It is seventy feet in length. 800 w. Bos Jour of Com—Sept. 24, 1898. No. 23045.

Torsion.

Instruments for Measuring Small Torsional Strains. E. G. Coker. Read at Bristol meeting of the British Assn. for the Adv. of Science. Describes two arrangements of apparatus intended for use in engineering laboratories and testing-houses for measuring such strains, and for the determination of the modulus of rigidity. Ill. 2000 w. Engng—Oct. 14, 1898. No. 23620 A.

U. S. Patents.

The United States Patent Office. An editorial criticism of this department of the United States government. 1200 w. Engng—Sept. 30, 1898. No. 23296 A.

Vacuum Bottle.

Les Verseurs Hermetiques. H. Joshua Phillips. Illustrated description of patent of Baron de Sennevoy—a device which permits any amount of liquid to be drawn from a bottle without admission of air or other substance. 1600 w. Ind & Ir—Sept. 23, 1898. No. 23227 A.

MILITARY ENGINEERING.

MILITARY ENGINEERING.

Aluminum.

The Use of Aluminum in the French Army. (Emploi de l'Aluminium dans l'Armée Française.) Showing the saving in weight by the use of aluminum cooking utensils, &c., and the extent to which they have been placed in the French army. 800 w. La Revue Technique—Sept. 25, 1898. No. 23512 D.

American Navy.

The United States Navy Under the New Conditions of National Life, P. H. Colomb. Considers the necessary changes and the expense that must be incurred to protect newly acquired territory, giving suggestions of a system of defense. 4500 w. N Am Rev—Oct., 1898. No. 23209 D.

The Navy in the War with Spain. Ira Nelson Hollis. Reviews the history of the naval part of the war and what the United States learned of value to naval development. 7000 w. Atlantic M—Nov., 1898. No. 23680 D.

Armor.

The Production and Supply of Armor for Naval Purposes. Introduction and outline of subject, with early armor experiments and their results comprise this first part. Ill. 3000 w. Ir & Coal Trds Rev—Sept. 23, 1898. Serial. 1st part. No. 23140 A.

Battleships.

Chief Characteristics of Battleships and Monitors Provided for in Naval Shipbuilding Programme of 1898-99. Outlines the leading features of design of the battleships and monitors to be constructed. 2200 w. Marine Engng—Oct., 1898. No. 23190 C.

Machinery of the "Maine." One of the three new battleships to be built is to be called the Maine. It is to be of the same general plan as the Alabama, and this article notes the changes which are to be made in the machinery. 1000 w. Bos Jour of Com—Oct. 1, 1898. No. 23151.

Our Latest Battleship. Brief description of the "Illinois," which was launched Oct. 4, 1898. 1200 w. Sci Am—Oct. 15, 1898. No. 23344.

Bombardment.

The Bombardment of Coasts. (Les Bombardments de Côtes.) Léo Dex. A discussion of the relative advantages of vessels and fortifications in connection with the attack and defense of coasts showing the importance of mortar fire with high trajectory against modern war ships. 2000 w. La Revue Technique—Sept. 25, 1898. No. 23508 D.

Cable Cutting.

Cable Cutting in War. George Ethelbert Walsh. Discusses the effect produced by cutting the cables and the means of protecting them in time of war. 2000 w. N Am Rev—Oct., 1898. No. 23210 D.

Cruiser.

Protected Cruiser "Philadelphia," of the United States Navy. Engraving and brief description of this cruiser which had the honor of carrying the annexation commission to Honolulu. 900 w. Sci Am—Oct. 1, 1898. No. 23084.

Disarmament.

See Economics and Industry, Miscellany.

Electricity.

The Use of Electricity in the Spanish American War. Thomas G. Grier. Paper read before the Chicago Elec. Assn. Summary of the applications, describing the methods employed at Fort Wadsworth, just below New York, the mines in Boston harbor, and other devices. 3000 w. Elec Wld—Oct. 15, 1898. No. 23326.

Gunnery.

Our Own Latest Marvel of Gunnery. Relates to the new "high angle firing" weapon soon to be introduced into the American navy. It is capable of being elevated so as to stand almost vertical with the deck, if necessary. 1100 w. Engng Mech—Oct., 1898. No. 23661 C.

H. M. S. Terrible.

The Steam Trials of H. M. S. "Terrible." A review of the results of recent trials. 2800 w. Engng—Sept. 30, 1898. No. 23297 A.

Merrimac.

The Sinking of the Merrimac. R. K. Crank. A detailed description of what happened in the engine room, given by the chief engineer. 3500 w. Am Mach—Oct. 6, 1898. No. 23263.

Naval Engineers.

The Modern Naval Engineer. Editorial discussion of the proposed change in personnel in the U. S. navy, and referring to the British views on the subject. 1400 w. Eng News—Oct. 27, 1898. No. 23676.

Naval Manoeuvres.

The French Naval Manœuvres of 1898. Editorial account of the manœuvres of the Mediterranean Squadron is given in part first. 2000 w. Engng—Oct. 7, 1898. Serial. 1st part. No. 23416 A.

Ordnance.

Naval Ordnance. Extract of the more important features of the annual report of the Bureau of Naval Ordnance of the United States, dealing with guns and mounts, small guns, efficiency, smokeless powder, and armor. 2400 w. Ir Age—Oct. 27, 1898. No. 23686.

On the Action of the Projectile and of the Explosives on the Tubes of Steel Guns. W. C. Roberts-Austen. Read before the Iron and Steel Inst., at Stockholm. A thorough examination shows that the action of the explosive upon the mass of the tube is purely mechanical, but at the extreme edge there is an altered layer. 1200 w. Ir & St Trds Jour—Sept. 17, 1898. No. 23169 A.

Report.

Report upon the Condition of Admiral Cervera's Vessels. Report in full after an examination by a Board of U. S. Naval Officers. Special attention is given to the effect of the U. S. gun fire, of combustible material, and explosions, with the conclusions drawn by the Board. Illustrations showing number and location of hits. 3000 w. Marine Engng—Oct., 1898. Serial. 1st part. No. 23192 C.

Sanitary Aspects.

Medical and Sanitary Aspects of the War. Dr. Carroll Dunham. A survey of the events of the late war in so far as they bear upon the health of the men. 9800 w. Am Rev of Revs—Oct., 1898. No. 23161 C.

Submarine Mines.

Explosion of Submarine Mines in Baltimore Harbor. Some account of the various kinds of mines with photographs showing their terrific energy. 1200 w. Sci Am—Oct. 1, 1898. No. 23085.

Torpedo Boats.

Torpedo-Boats for the Austrian Navy. Editorial on the trial trip of the "Boa," one of the vessels built for the Austro-Hungarian government, with general remarks on this class of marine construction. 1700 w. Engng—Sept. 23, 1898. No. 23147 A.

Torpedo-Boats in the War with Spain. John R. Spears. Reviews what these boats did in the war, showing that they served mostly as dispatch-boats, and pickets. That they could not resist modern rifle projectiles, but that this is the most dangerous service, and did much to improve the *personnel* of the navy. 4200 w. Scribner's Mag—Nov., 1898. No. 23652 C.

See Electrical Engineering, Lighting.

War Costs.

The Cost of the War. Frank A. Vanderlip. An interesting article by the assistant secretary of the Treasury, discussing the cost of the war with Spain. 4000 w. McClure's Mag—Oct., 1898. No. 23180.

War Engineering.

The Work of the Engineers in the Santiago Campaign. Eduardo J. Chibas. Map of the district around Santiago, showing the positions of the United States and Spanish forces, with a statement of the work done by the engineers during the advance. 3500 w. Eng News—Oct. 13, 1898. No. 23334.

War Lessons.

Some Lessons of the War from an Officer's Standpoint. John H. Parker. Considers some of the causes of needless suffering, and some of the changes that have been made necessary by improved rifles and by the use of the machine gun. 3800 w. Am Rev of Revs—Oct., 1898. No, 23162 C.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

Causes of Accidents. Extracts from the reports of the several mine inspectors of the State of Pennsylvania regarding the causes of accidents in mines. Also some recommendations by which the number of injuries may be reduced. 4000 w. Mines & Min—Oct., 1898. No. 23171 C.

Reports on the Whitwick Colliery Accident. Report on the circumstances attending an underground fire and which resulted in the loss of thirty-five lives. 6600 w. Col Guard—Sept. 23, 1898. No. 23134 A.

Breaker.

The New Breaker at Cranberry Coal-Mine, Hazleton, Pa. W. S. Ayres. A detailed description of the new breaker, made necessary by a destructive fire, considering the foundations, frame of structure, machinery, chutes and connections, with a statement of results. Ill. 10,500 w. Am Inst of Min Engs—Oct., 1898, No. 23381 D.

Boiler Plant.

Mine Boiler Plant at Hazleton Shaft Colliery of the Lehigh Valley Coal Co., Hazleton, Pennsylvania. An illustrated description of a thoroughly modern plant using forced and induced draft, economizer, and water for removing ashes from the boiler room. 2000 w. Mines & Min—Oct., 1898. No. 23173 C.

Brick-Making.

Brick-Making from Coal-Measure Shale. From a communication by M. Sylva Cottier to the Soc. of Hainaut Mining Engs. Describes the work as carried on by the Marles Colliery Co. in the north of France. 1300 w. Col Guard—Sept. 30., 1898. No. 23288 A.

By-Products.

Modern Appliances for the Recovery of By-Products from Coking Coal. From *Stahl und Eisen.* Describes a German plant and the manner of recovering the products. 1500 w. Gas Wld—Oct. 15, 1898. No. 23603 A.

Some Notes on Recovery Plant in By-Product Coking. Rudolph Terhaerst in *Stahl und Eisen.* General remarks on by-product plants, with description of ovens and condensing apparatus. 1800 w. Ir & Coal Trds Rev—Sept. 23, 1898. No. 23139 A.

Carboniferous Rocks.

The Yoredale Series. Wheelton Hind. Read before the Geological Soc. of London. Information concerning the carboniferous rocks of Great Britain. 5000 w. Col Guard—Oct. 14, 1898. Serial. 1st part. No. 23609 A.

Coal-Cutting.

Coal-Cutting by Machinery. G. C. Allsebrook. Abstract of a paper which has been awarded the annual prize of £5 offered by the Inst. of Min. Engs. for the best essay written by a student or member under twenty-five years of age. Shows the need of coal-cutting machinery, the advantages from its introduction, the effect upon the workmen, the essentials of a good machine, &c. 2400 w. Col Guard—Oct. 7, 1898. No. 23411 A.

Coal Cutting by Machinery. W. E. Garforth. A contribution to the discussion of W. T. Goolden's paper, read at the London meeting of the Inst. of Min. Engs. Ill. 1600 w. Col Guard—Sept. 23, 1898. No. 23131 A.

Coal Handling.

The Automatic Manipulation of Coal and Coke. Gilbert Little. Abstract of a paper read before the Inst. of Mining Engs. describing several systems of machinery for dealing economically with the loading, distribution and cleaning. 1300 w. Col Guard—Sept. 30, 1898. No. 23290 A.

Coal-Handling Machinery. Notes the causes which have led to the development of economical methods of handling coal in power stations, giving illustrated descriptions of some of the installations. 1600 w. St Ry Rev—Oct. 15, 1898. No. 23454 C.

Coal Region.

The Blossburg Coal Region. Anton Hardt. Its location and geology, the mining methods and machinery used, also analyses of the coals from different mines. 1500 w. Mines & Min—Oct., 1898. No. 23178 C.

Coal Trade.

See Economics and Industry, Commerce and Trade.

Coke Making.

Coke Making for Profit. Fred C. Keighley. Part 1st discusses the most profitable plant, giving facts of interest to those in the coke business. 2300 w. Am Mfr & Ir Wld—Sept. 30, 1898. Serial. 1st part. No. 23214.

Colliery Warnings.

Colliery Warnings: Their Utility Called in Question. W. Fairley, in *Mining Engineering*. Considers that no instrument yet constructed can give warning of the approach of firedamp. 1000 w. Can Min Rev—Sept., 1898. No. 23166 B.

Competition.

The Competition of West Virginia with Ohio Coal. E. H. Coxe. A statement of some of the conditions governing this competition. 1200 w. Eng & Min Jour—Oct. 8, 1898. No. 23-194.

Fifeshire.

A Visit to Fifeshire Collieries. Notes on features of interest observed at Dalbeath, Mossbeath, Kirkwood Pit and Aitken Pit. 2000 w. Col Guard—Oct. 7, 1898. No. 23410 A.

India Collieries.

The Indian Railway Coal Supplies and Indian Collieries. Brief account of the collieries which chiefly supply the Indian railways, their outputs, and the quantity of coal raised per person employed. 1800 w. Ir & Coal Trds Rev—Oct. 14, 1898. No. 23614 A.

New South Wales.

The Coal Mines of New South Wales. Extracts from a very complete report by A. A. Atkinson, discussing ventilation, methods of working, haulage, lighting of mines, and methods of signalling. 1800 w. Ir & Coal Trds Rev—Sept. 30, 1898. No. 23279 A.

Peru.

Anthracite Coal in Peru. William Griffith. The geology and extent of the deposits and the qualities of the coal found in them. 1500 w. Mines & Min—Oct., 1898. No. 23176 C.

Preparation.

The Mechanical Preparation Works at the St. Eloy Collieries. (Atelier de Préparation Mécanique aux Houillères de Saint Eloy, Puy-de-Dôme.) A fully illustrated account of the conveyors, travelling belts, washing apparatus, &c., with plans of the general installation of the plant. 1800 w. Le Génie Civil—Sept. 17, 1898. No. 23500 D.

Pumping Plant.

New Electric Pumping Plant at Arniston Colliery, Gorebridge, N. B. Describes the plant, which, exclusive of the building of the power stations, has cost about £12,000. 900 w. Col Guard—Sept. 23, 1898. No. 23132 A.

South Africa.

South African Coal. Editorial on the trials and results to ascertain the relative value of the various kinds of coal used by the locomotive department of the government railways. The coals tried were the Welsh, Cape Colonial, Orange Free State and Transvaal. 1100 w. Engng—Oct. 14, 1898. No. 23618 A.

Stocking Plant.

Plant for Stocking, &c., Patent Fuel at a French Colliery. M. Castellan. Communicated to the Société de l'Industrie Minérale. Illustrates and describes the arrangements for stocking *boulets*, a fuel made of fine slack from anthracite. 1200 w. Col Guard—Oct. 7, 1898. No. 23408 A.

COPPER.

Converter.

The Paul David "Selecteur" or Converter. Paul Louis Barthe. Abstract of article in the *Annales de Mines*. Illustrates and describes improved apparatus used in the metallurgy of copper, its working, and advantages. 2200 w. Eng & Min Jour—Oct. 22, 1898. No. 23633.

Copper Depositing.

The Dumoulin Copper Depositing Process. John B. C. Kershaw. Describes the manufacture of copper tubes and sheets by electrolytic deposition. Ill. 1500 w. Elec Rev, Lond—Oct. 14, 1898. No. 23492 A.

Copper-Mattes.

The Elimination of Impurities from Copper-Mattes in the Reverberatory and the Converter. Edward Keller. A contribution to the discussion of this paper, giving the writer's reply to the remarks of Dr. Peters. 2400 w. Am Inst of Min Engs—Oct., 1898. No. 23380 D.

GOLD AND SILVER.

Address.

The President's Inaugural Address. J. Loevy. Address before the society dealing with chemical subjects directly or indirectly connected with the metallurgy of gold. 3800 w. Jour of Chem & Met Soc of S Africa—Aug., 1898. No. 23224 E.

Assaying.

A New Assay for Mercury. Richard E. Chism. Shows the uncertainty of some methods, the drawbacks of the gold method, and describes the use of silver for receiving the mercury. 2500 w. Am Inst of Min Engs—Oct., 1898. No. 23373 D.

Chlorination.

The Chlorination Mill at Colorado City, Colorado. H. V. Croll. Brief description of plant designed to treat the ores of Cripple Creek and other districts. Ill. 1800 w. Eng & Min Jour—Oct. 8, 1898. No. 23195.

Concentration.

Concentration. S. J. Hallett. Describes coarse and fine concentration. 1600 w. Min Rept—Oct. 6, 1898. No. 23320.

Cyanide.

Aids to the Cyanider. Matt W. Alderson. The paper aims to show how certain well known facts may be utilized to advantage in every day work, and how tests may be made and conclusions reached without the aid of a chemist. 2300 w. Min & Sci Pr—Oct. 15, 1898. No. 23471.

The Estimation of Oxygen in Working Cyanide Solutions. Andrew F. Crosse. A contribution to analytical chemistry giving a simple method of determining the amount of oxygen in cyanide solutions. 3300 w. Jour of Chem & Met Soc of S Africa—Aug., 1898. No. 23225 E.

Electrodeposition.

The Electro-deposition of Gold in the Transvaal. (L'Electrodéposition de l'Or au Transvaal.) Dr. Andréoli. An account of the practical operation of the Siemens & Halske process in South Africa. Serial. Part 1. 1500 w. Electricien—Oct. 1, 1898. No. 23555 B.

Gippsland, Victoria.

Notes on the Auriferous Devonian Formations of Gippsland, Victoria. H. Herman. The writer concludes that there is not yet sufficient reason for altering the opinion that the great mass of the Upper Devonian rocks of Victoria should be considered, in general, non auriferous. 3500 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23390 G.

Gold Dredging.

Hydraulic Dredging, or the Working of Deep Alluvial Deposits by Elevation with Centrifugal Pumps. A. S. Kenyon. Illustrates and describes the system in use. 3000 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23393 G.

Notes on Gold-dredging, with Reference to the Introduction of the Industry into New South Wales. J. B. Jaquet. A report upon the results obtained and the machinery used. 7500 w. N Z Mines Rec—Sept. 16, 1898. No. 23645 B.

Goldfield.

A Neglected Goldfield. An account of the Inglewood reefs, in Victoria, showing that a course of systematic mining would give satisfactory results. 2200 w. Aust Min Stand—Aug. 18, 1898. Serial. 1st part. No. 23308 B.

Berringa, Vic. An illustrated account of this field discussing its prospects. 1600 w. Aust Min Stand—Sept. 15, 1898. No. 23646 B.

Gold-Milling.

Some Notes on Gold-Milling. W. H. Vale. Results of the writer's experience, showing, from an economic point of view, what he has found best suited to his particular work. 2200 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23387 G.

Gold Structure.

Microscopic Structure of Gold and Gold Alloys. Thomas Andrews. An account of a series of experiments to determine the microphysical structure. Part first considers the structure of pure gold. Ill. 1000 w. Engng—Sept. 30, 1898. No. 23294 A.

Kalgoorlie.

Kalgoorlie, Western Australia, and its Surroundings. Edward S. Simpson's discussion of this paper, with reply by the writer, George J. Bancroft. 1200 w. Am Inst of Min Engs—Oct., 1898. No. 23375 D.

Klondike.

Notes from the Klondike. A. N. C. Treadgold. Descriptive of the region and existing conditions. 4500 w. Can Min Rev—Sept., 1898. No. 23164 B.

The Country of the Klondike. Russell L. Dunn. Statements based on observations and information obtained during a recent visit to the basins of the Yukon and Alsek rivers. 2800 w. Min & Sci Pr—Oct. 22, 1898. Serial. 1st part. No. 23683.

The Klondike Gold Fever. D. Zahn. Translated from *Ueber Land und Meer*. An account of the rush to this field, difficulties of travelling and living, with report of one who made the journey. 1400 w. Chau—Nov., 1898. No. 23682 C.

Lode-Locations.

Mineral Lode-Locations in British Columbia. William Braden. An account of the trial and abandonment of this feature, and the working of the Mineral act as it stands to-day. 1500 w. Am Inst of Min Engs—Oct., 1898. No. 23378 D.

Mercur.

Gold Mines of Mercur, Utah. Don Maguire. How the large bodies of low grade ores found there are profitably treated, with description of some of the peculiar ore deposits, the chemical problems their treatment presents, and the methods by which they are solved at the Golden Gate mines. 2700 w. Mines & Min—Oct., 1898. No. 23179 C.

New Zealand.

Minerals in the Gold-Bearing Reefs of the Thames. F. B. Allen. Considers minerals other than pyrites which are found on the Thames goldfield. 2400 w. N Z Mines Rec—Aug. 16, 1898. No. 23052 B.

Nova Scotia.

The Ores of Nova Scotia. From a report by E. Gilpin, Jr. Deals largely with the gold and silver ores, but mentions rich deposits of copper, coal, iron ore, gypsum and other minerals. 4000 w. Col Guard—Sept. 30, 1898. No. 23289 A.

Ore Deposits.

The Superficial Alteration of Western Australian Ore-Deposits. Herbert C. Hoover. Describes the nature of the deposits and points out the special peculiarities of the phenomena observed in Western Australia. 2500 w. Am Inst of Min Engs—Oct., 1898. No. 23374 D.

Placer Gold.

Placer Gold and How It Is Secured. John E. Bennett. An explanation of what placers are, how formed, and an illustrated description of the methods of placer mining. 3500 w. Cos—Nov., 1898. No. 23430.

Refining.

The Refining of Base Lead Bullion Containing Silver, and High in Gold. G. H. Blakemore. Describes the operation of refining base bullion. 10,000 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23391 G.

Silver Ores.

The Reduction Works for Silver Ores, at

Aduana, Sonora, Mexico. Miltiades Th. Armas. A brief geographical description, the kinds of ores and methods applied. 2700 w. Jour Fr Inst—Oct., 1898. Serial. 1st part. No. 23203 D.

Slimes.

A Few Notes and Observations on the Reduction and Ore Dressing of Auriferous Quartz Veinstone in Victoria. Henry Rosales. Deals with the methods practiced on several of the goldfields of Victoria, especially the systematical treatment of slimes. 3400 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23384 G.

Treatment of Slimes. W. B. Gray. Gives experience in the treatment of the water which overflows from the cyanide vats and carries off the slimes in suspension, dealing with the collection of the slimes, their treatment by cyanide, and the precipitation of the gold by charcoal. 1500 w. Trans Aust Inst. of Min Engs—Vol. V. No. 23388 G.

Smelting.

Reverberatory Furnace Smelting of Ores. Thomas J. Dyson. Describes a method in use at a European smelting works, based on the mutual reduction of oxide and sulphide of lead when heated together. 1400 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23383 G.

Smelting Gold and Silver Ores in Colorado. Thomas Tonge. The development of the industry and its effects on the mining business. The locations and capacities of the plants and statistics in regard to their output of precious and other metals. Ill. 3700 w. Mines & Min—Oct., 1898. No. 23170 C.

Source of Metals.

The Source of Gold and Other Metals. Henry A Gordon. Abstract of a paper read before the New Zealand Inst. of Min. Engs. Discussing where metallic substances come from and quoting the opinions of many writers. 4000 w. N Z Mines Rec—Aug. 16, 1898. No. 23051 B.

Witwatersrand.

Some Notes on the Mining Practice of the Witwatersrand Goldfields, South African Republic. G. A. Denny. Calls attention to the features peculiar to this district, and describes the mining methods, which represent the most advanced teaching of modern science and experience. Ill. 20,000 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23382 G.

Yukon.

The Yukon Royalty. A. N. C. Treadgold. Discusses the justice of the royalty imposed, concluding that the crown keeps back too much considering the conditions. 1500 w. Can Min Rev—Sept., 1898. No. 23163 B.

IRON AND STEEL.

Analysis.

The Physical Analysis of Steel. John Parry. Read before the South Wales Inst. of Engs. The writer has attempted to collect the essential facts, useful to the manufacturer, that have been obtained by microscopical investigations. 3300 w. Col Guard—Sept. 23, 1898. No. 23136 A.

Birmingham, Ala.

A Great Outlook for Birmingham. James Bowron. Full text of address at the Cincinnati meeting of the Am. Foundrymen's Assn. A statement of the conditions which have helped to advance the iron and steel industries at this place, the importance of the coal deposits, &c. 4000 w. Ir Trd Rev—Sept. 22, 1898. No. 23059.

Blast Furnaces.

Iron Carbonyl in the Blast Furnace. F. P. Venable. Some facts with regard to the possible part played by this compound in blast furnace processes. 900 w. Am Mfr & Ir Wld—Oct. 28, 1898. No. 23703.

Iron Extraction.

The Extraction of Iron from Its Ores in the Blast Furnace. James Tomkins. From a paper read before the Derbyshire Metallurgical and Engineering Assn. Deals with the treatment of the iron ore in the furnace. 2500 w. Col Guard—Sept. 30, 1898. No. 23291 A.

Iron Formation.

An Extensive Iron Formation, West Coast of Tasmania. David Jones. Describes one of the largest deposits of iron known in Tasmania, and probably in the world. 2000 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23386 G.

Iron Mixer.

The Jones Iron Mixer Patent. Illustration and a summary of the specifications of this patent, the object of which is to make the product of the converters as uniform as possible. 1300 w. Eng & Min Jour—Oct. 1, 1898. No. 23103.

Iron Works.

The Hofors Iron Works, Sweden. Illustrated description. 2500 w. Engng—Oct. 7, 1898. No. 23414 A.

The Plant of the Pencoyd Iron Works, Pencoyd, Pa. Detailed description with drawings and illustrations. 4500 w. Eng News—Sept. 29, 1898. No. 23073.

Reversing Engine.

See Mechanical Engineering, Engines.

Review.

Review of Recent Progress in the Metallurgy of Iron. (Revue des Progrès Récents de la Metallurgie du Fer.) MM. de Billy & Marillier. The annual review of the *Société d'Encouragement*, giving a résumé of the notable advances made during the year. 7500 w. Bulletin de la Société d'Encour—Sept., 1898. No. 23517 G.

Rolling Mills.

Improvements in Rolling Mills. Condensed from account by E. Weber, in *Stahl und Eisen*. Illustrated description of a proposed new arrangement for roll trains. 1700 w. Ir & Coal Trds Rev—Sept. 30, 1898. No. 23278 A.

The New Plate Rolling Mills of the Rasselstein Iron Works. (Das Neue Platinenwalzwerk der Rasselsteiner Eisenwerks Gesellschaft.) A brief account of these new rolling mills in Rhenish Prussia, with plate of plans and sections. 1000 w. 1 plate. Stahl und Eisen—Oct. 1, 1898. No. 23563 D.

The New Strip Mills of the Rasselstein Ironworks. From *Stahl und Eisen*. Illustrated detailed description of a mill in Germany presenting features of interest. 700 w. Ir & Coal Trds Rev—Oct. 14, 1898. No. 23615 A.

Russia.

The Development of the Russian Iron and Steel Industry. From the London *Times*. Facts showing the growth of this industry. 1400 w. Col Guard—Sept. 23, 1898. No. 23135 A.

Santiago.

Santiago Iron Mines. An illustrated description and history of the principal iron and manganese mines of Cuba, by whom they are operated, the quality of the ores, the methods by which they are mined, and the facilities for handling and transportation. 2000 w. Mines & Min—Oct., 1898. No. 23174 C.

Scotland.

The Ironmaking Districts of Scotland. Part first describes the tube industry of Coatbridge. Ill. 1300 w. Ir & Coal Trds Rev—Sept. 23, 1898. No. 22138 A.

Steel Production.

Jones & Laughlin Co., Ltd., and the Production of Steel. A description of the plants and equipment of a modern metal working establishment near Pittsburg. 2000 w. Elec Eng, N. Y.—Oct. 20, 1898. Serial. 1st part. No. 23443.

MINING.

Economics.

On the Economics of Mining. J. R. Godfrey. Discusses methods of exploiting a mine, flotation and over-capitalization, management, and the steps that should be taken to prevent loss. 6000 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23389 G.

Explosives.

Testing Mining Explosives. Perry F. Nursey. A discussion of the first report of Captain Cooper-Key, upon the work at the government testing station at Woolwich, where explosives are searchingly tested. 2400 w. Ind & Ir—Sept. 30, 1898. No. 23281 A.

Firedamp.

The Firedamp Explosions in the Upper Dortmund District. (Die Schlagwetterexplosionen im Oberbergamtsbezirk Dortmund.) A tabulated report of the mine explosions of 1897, with a chart of barometric curves, showing the relation of explosions to atmospheric pressure. 2000 w. 1 plate. Glückauf—Sept. 17, 1898. No. 23567 B.

Forest Reserves.

Mining and the Forest Reserves. Gifford Pinchot. A brief statement of the regulations prescribed under the law, showing that the reservation does not interfere with the development of mineral wealth, but is of positive value to the miners. 2800 w. Am Inst of Min Engs—Oct., 1898. No. 23379 D.

Haulage.

Mining Haulage. G. W. Westgarth. From the *Journal of the British Society of Mining Students*. Deals with haulage underground, suggesting where economy may be effected, and showing how installations are rendered unsatisfactory by a misapplication of the load. 7800 w. Can Min Rev—Sept., 1898. No. 23165 B.

Mine Accounts.

Keeping Mine Accounts. Deals with the arrangement of mine accounts for the cost sheet rather than the method of keeping them in detail. 2000 w. Ir & Coal Trds Rev—Sept. 23, 1898. No. 23137 A.

Mining Contracts.

Questions Arising on Mining Contracts. Gives cases illustrating the sort of questions arising and of the principles of British law that are applied to their decision. 3000 w. Col Guard—Sept. 30, 1898. No. 23286 A.

Mining Plant.

Improvements in Mining Plant and Methods. From an official report on the working of the Prussian mines during 1897. Part first deals mainly with blasting. 2500 w. Col Guard—Sept. 30, 1898. Serial. 1st part. No. 23285 A.

Pelton Wheel.

The Applications of the Pelton Motor in Mining Work. (Ueber den Pelton motor und seine Anwendung im Bergwerksbetrieb.) C. Blecken. Showing the especial applicability of wheels of this class to mining service. 2000 w. Glückauf—Oct. 1, 1898. No. 23569 B.

Preservation.

The Hasselmann Impregnating Process. (Ueber das Hasselmannsche Imprägnierungs-Verfahren.) Max Krause. A method of charging the pores of wood with chloride of zinc, claimed to be especially adapted for mine timbers. 2000 w. Glückauf—Sept. 24, 1898. No. 23568 B.

Respirators.

Improved Life Saving Respirators. (Les Nouveaux Appareils Respiratoires de Sécours.) H. Schmerber. Describing particularly the pneumatophore of Walcher & Gaertner, and also the Mayer & Pilar apparatus. The carbonic acid of the breath is absorbed by caustic potash, and a supply of compressed oxygen is carried. 2500 w. Le Génie Civil—Oct. 1, 1898. No. 23503 D.

Tasmania.

Tasmanian Mining Laws. J. W. Hudson. A statement of reforms that the writer considers necessary to make this field attractive to capitalists 2400 w. Aust Min Stand—Sept. 8, 1898. No. 23331 B.

Timbering.

The Applicability of Certain Kinds of Wood for Mine Timbers. (Ueber die Gebrachsfähigkeit einiger Holzarten zum Grubenausbau.) Ch. Dütting. Giving the results of endurance tests of various kinds of mine timbers, and methods of timber preservation. 2500 w. Glückauf—Oct. 8, 1898. No. 23570 B.

Timbering in the Iron Ore Mines of Cumberland and Furness. John L. Hedley and William Leck. Abstract of a paper read before the Inst. of Engs., England. 2200 w. Col Guard—Sept. 23, 1898. No. 23133 A.

MISCELLANY.

A. I. M. E. Meeting.

The Mining Engineers meeting of the American Institute at Buffalo. A brief account of the meeting with abstracts of papers presented. 7500 w. Ir Age—Oct. 27, 1898. No. 23685.

Aluminum.

Aluminum as a Reducing Agent and a Source of High Temperatures. The investigations of Dr. Hans Goldschmidt are reported, which have made it possible to produce metals on a large scale and to utilize in other ways the temperature produced by the reaction. Explains its use in the production of metallic chrome and manganese and of corundum. 1500 w. Ir Age—Oct. 6, 1898. No. 23239.

Ashcroft Process.

The Ashcroft Process for the Treatment of Mixed Lead and Zinc Sulphide Ores. Walter Renton Ingalls. A statement of the difficulties encountered at Cockle Creek, N. S. W., and some of the features involved in the problem. Also editorial. 5000 w. Eng & Min Jour—Oct. 22, 1898. No. 23634.

Clay.

Clay Resources of Missouri. H. A. Wheeler. These clays comprise all the varieties used in the arts and are found in great abundance. 2200 w. Eng & Min Jour—Oct. 8, 1898. No. 23196.

Clays of Louisiana. W. W. Clendennin. Report of the deposits thus far known, which when developed, give promise of becoming an important source of wealth. 900 w. Eng & Min Jour—Oct. 15. 1898. No. 23405.

Corundum.

Corundum. Extract from the report of the Ontario Bureau of Mines, 1898. The conditions under which the mineral occurs, its varieties, composition, &c. 3200 w. Can Eng—Oct., 1898. No. 23304.

Diagrams.

Note on the Use of the Tri-Axial Diagram and Triangular Pyramid for Graphical Illustration. Henry M. Howe. Calls attention to the tri-axial diagram as a convenient means of illustrating the properties of slags, and commends it to those inclined to graphical studies, having other possible applications. 2200 w. Am Inst of Min Engs—Oct., 1898. No. 23372 D.

Fire Brick.

Bauxite Firebrick. Calls attention to this variety of firebrick, also describing magnesia and other brick. 800 w. Clay Rec—Sept. 26, 1898. No. 23400.

Fire Clays.

A Modification of Bischof's Method for Determining the Fusibility of Clays, as Applied to Non-Refractory Clays, and the Resistance of Fire-Clays to Fluxes. H. O. Hofman. Explains the direct and indirect methods, and describes the modification and the experimental tests made to verify the method. 1500 w. Am Inst of Min Engs—Oct., 1898. No. 23377 D.

Does the Size of Particles Have any Influence in Determining the Resistance of Fire Clays to Heat and to Fluxes? H O Hofman, and B. Stoughton. Report of a series of tests made, giving tabulated results. 800 w. Am Inst of Min Engs—Oct , 1898. No. 23376 D.

Gas Producers.

Gas Generators Albert Sailler. A lecture delivered before the Austrian Assn. of Engs. and Architects. Translated from the *Zeitschrift für das Gas und Wasserfach.* Discusses principally the metallurgical apparatus in which the fractional combustion of fixed carbon is involved, describing his own system, and giving results. 2500 w. Pro Age—Oct. 15, 1898. No. 23362.

The Riche Gas Producer. A, Lombard. Translated from the French Describes the producer and its working. 1200 w. Am Mfr & Ir Wld—Oct. 7, 1898. No. 23312.

Glass.

Continuous Operation in the Manufacture of Window Glass Robert Linton Especially devoted to the history of the development of the continuous tank furnace as opposed to the older melting pots; with illustrations of German, French, and American furnaces. 3000 w. Engineering Magazine—Nov., 1898. No. 23-597 B.

India.

See Economics and Industry, Commerce and Trade.

Kryolith.

Kryolith—Its Mining, Preparation and Utilization. The only deposit of commercial importance known is in Greenland. Its principal use is in the manufacture of soda. 2000 w. Min & Sci Pr—Oct. 1, 1898 No. 23232.

Marble.

The Marble Mountains of Italy. Vernon Lee. Descriptive. 1500 w. Stone—Sept., 1898. No. 23037 C.

Metal Working.

The Spinning, Stamping, and Working of Aluminum and Brass Sheet. From the *Aluminum World.* The more general use of the aluminum sheet is noted and some facts related to its working. 1600 w. Sci Am Sup—Oct. 15, 1898. No. 23346.

Nickel.

Nickel. Arthur Lakes. Its ores and some of their distinguishing peculiarities. Where they are found 1000 w. Mines & Min—Oct., 1898. No 23177 C.

The Mining, Smelting, and Refining of Nickel. Titus Ulke. With views of the mines and smelting works, and a detailed account of the methods and costs of nickel production. 3000 w. Engineering Magazine—Nov., 1898. No. 23595 B.

Petroleum.

Southern California Petroleum. A. S. Cooper.

Describes the Summerland oil-field. Nearly all the oil found in California is in dunes. Petroleum is pumped from under the sea. Ill. 600 w. Min & Sci Pr—Oct. 15, 1898. No. 23469.

Platinum.

The Platinum Metals of Plumas County, California. J. A. Edman. Some notes on platinum, with iridium, osmiridium, and iridosmium, found in several of the deep gravel channels and in some surface gravels. 1000 w. Min & Sci Pr—Oct. 22, 1898. No. 23684.

Screening.

Graphic Records of the Screening of Crushed Materials. Courtenay DeKalb. Results of studies of the behavior of ores or rocks when subjected to crushing under different conditions. 2000 w. Am Inst of Min Engs—Oct., 1898. No. 23371 D.

Smelting.

Zinc Smelting in the Joplin District. E. Hedburg. The process used is described and some figures as to cost and profit given. Ill. 1500 w. Mines & Min—Oct., 1898. No. 23172 C.

Stone.

The Stone Industry of Alabama. Eugene A. Smith. Information concerning the building and ornamental stones of this state. 1400 w. Eng & Min Jour—Oct. 1, 1898. No. 23102.

Tasmania.

The Igneous Rocks of Tasmania. W. H. Twelvetrees and W. F. Petterd. Investigations of the igneous petrology of this island. 5800 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23385 G.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene. George French. An exposition of the wet process. 1500 w. Heat & Ven—Oct. 15, 1898. No. 23671.

Acetylene Plant for House Supplies. Considers the most promising sphere of usefulness to lie in the supply of buildings which are out of the reach of the mains of gas-works undertakings. Emphasizes the need of proper purification and comments favorably on the generator patented by Prof. Raoul Pictet of Germany. 1400 w. Jour of Gas Lgt—Oct. 4, 1898. No. 23361 A.

Dangers in the Generation and Use of Acetylene. (Ueber die Gefahren bei der Erzeugung und Verwendung von Acetylen.) Dr. H. Gerdes. An account of the experiments made at the Pintsch works at Berlin, showing that with reasonable precautions no serious dangers need be incurred. The use of mixed acetylene and oil-gas for lighting railway carriages is discussed. 6000 w. Glaser's Annalen—Sept. 15, 1898. No. 23540 D.

The Acetylene Gas Hazard. L. J. Krom. Contending that acetylene is no more dangerous than ordinary illuminating gas, and discussing the restrictions of proposed legislation, giving results of experiments. 1100 w. Sci Am—Oct. 8, 1898. No. 23234.

Wet and Dry Acetylene Generators. H. F. Fuller. Part first is confined to the wet process, discussing the advantages claimed. 1000 w. Heat & Ven—Oct. 15, 1898. Serial. 1st part. No. 23672.

Address.

Address of the President of the American Gas Light Association, at its Twenty-sixth Annual Meeting, Niagara Falls, N. Y. J. B. Crockett. Touches briefly on many questions of interest to this industry, considering the future outlook encouraging. 5500 w. Am Gas Lgt Jour—Oct. 24, 1898. No. 23631.

By-Products.

Producing Illuminating Gas and Coke in By-Product Coke Ovens. H. O. Hofman. An outline of the work done at Halifax, N. S., by the People's Light and Heat Co., and of the preliminary large-scale experiments made for the New England Gas & Coke Co., at Glassport, Pa., with the coal that is to be used in the new Boston plant. 3000 w. Eng & Min Jour—Oct. 8, 1898. Serial. 2 parts. No. 23197.

Carbide.

Analyses of Commercial Samples of Calcium Carbide. (Analyse de quelques Echantillons Industriels de Carbure de Calcium.) Henri Moissan. A communication to the French Academy, showing the character and extent of the impurities in calcium carbide based upon the analyses of a number of samples from various sources. 2000 w. Comptes Rendus—Oct. 3, 1898. No. 23539 D.

The Present and Prospective Supply of Calcium Carbide. Brief report of the situation in Europe, the conditions of supply and price, which are likely to be greatly modified by the increased production. 900 w. Cons Repts—Sept., 1898. No. 23025 D.

Carbonization.

A Few Hints on Carbonization. S. Carpenter. Suggestions to young gas managers and students. 2200 w. Jour Gas Lgt—Sept. 27, 1898. No. 23240.

Development.

How Can We Make the Use of Gas More Universal? Henry L. Doherty. Read before the Am. Gas Lgt. Assn. at Niagara Falls. States reasons why gas is not used more generally for cooking, discussing each in order. 4800 w. Am Gas Lgt Jour—Oct. 31, 1898. No. 23702.

Gas Burners.

Introduction of Incandescent Gas Burners for Public Illumination at Paris. From the *Journal des Usines a Gaz.* Particulars relating to the installation of the Denayrouze incandescent gas burner in the principal streets and squares of Paris. 700 w. Am Gas Lgt Jour—Oct. 3, 1898. No. 23168.

Gas Mixtures.

On the Occurrence of Hydrogen Sulphide in the Natural Gas of Point Abino, Canada; and on a Method for the Determination of Sulphur in Gas Mixtures. Francis C. Phillips, in Jour. Am. Chem. Soc. A summary of tests made at the wells and results obtained. Ill. 3000 w. Am Gas Lgt Jour—Sept. 26, 1898. No. 23043.

Gas Statistics.

New York State Gas Statistics. Interesting facts from the 15th Annual Report of the Bureau of Labor Statistics of New York for the year 1897. 1600 w. Pro Age—Oct. 1, 1898. No. 23110.

Meters.

Prepayment Meters in Manchester, England. Charles Nickson. A brief account of the difficulties, increased demand for gas, and the financial results from their introduction. One year's collection of pennies amounted to 4,727,541, or a weight of 44 tons. 900 w. Gas Wld—Sept. 24, 1898. No. 23121 A.

New Gas.

A New Gas. Charles F. Brush. Read befor the Am. Assn. for the Adv. of Science. A brief account of the circumstances that led to the discovery. The chief characteristic thus far ascertained is enormous heat conductivity at low pressures. 5000 w. Science—Oct. 14, 1898. No. 23348.

Oxide.

The Manufacture of "Oxide" in the Gas Works, from the Standpoint of the Man Outside. W. H. Birchmore. Discussion of points in the manufacture of oxide, and the variation in the products bearing this name. 2800 w. Am Gas Lgt Jour—Oct. 17, 1898. No. 23402.

Standards.

A Comparison of the Hefner and Carcel Lamps as Standards of Light. Relates to the researches of M. Laporte, and the conclusions drawn from his results. 900 w. Jour of Gas Lgt.—Oct. 11, 1898. No. 23448 A.

Water Gas.

Dellwik's Water Gas. Abstract of a lecture recently delivered by the inventor before the Swedish Teknologförening at Stockholm, describing the producer and discussing the manipulation, composition and cost. Ill. 900 w. Gas Wld—Oct. 1, 1898. No. 23268 A.

Welsbach Mantles.

Deterioration of the Candle Power of Welsbach Mantles. Report of recent investigations claiming to show that the drop in candle power of Welsbach mantles is even more rapid than that of the filaments of incandescent lamps. 600 w. Elec Wld—Oct. 1, 1898. No. 23089.

SEWERAGE.

Concrete Pipes.

A French Achievement. Describes a sewage force-main 4,793 ft. long built of concrete and steel bars. 800 w. Eng Rec—Oct. 22, 1898. No. 23622.

Purification.

Purification of Sewage by Irrigation. W. M. Watson. Discusses methods and their degree of success, describing the sewage form of St. Laurent College, near Montreal and also the sewage works of the Georgean Bay district. 1700 w. Can Eng—Oct., 1898. No. 23298.

Purification of Sewage by Mixing with Pure Water. W. M. Watson. Thinks it perhaps possible that a rapid-flowing river might purify its contents, but considers it improbable that it will purify raw sewage. 1300 w. Can Eng—Oct., 1898. No. 23302.

Sewage Disposal.

A Short History of Sewage Disposal at the Asylum for the Insane, London, Ontario. R. M. Bucke. Read before the Ontario Assn. of Executive Health Officers at Ottawa. Describes an intermittent downward filtration plant, stating its advantages. 1400 w. Can Eng—Oct., 1898. No. 23300.

Recent Methods of Sewage Disposal. Charles G. Horetzky. Read before the Assn. of Executive Health Officers of Ontario, and before the Am. Public Health Assn. Considers the most recent methods in operation in the United States, with remarks on their adaptability to cities in Canada. 3300 w. Can Eng—Oct., 1898. No. 23301.

Sewage Disposal at Friern Barnet, England. James H. Fuertes. Illustrated description of a plant with many ingenious mechanical devices, which was built by Baldwin Latham in 1887. Chemical treatment and filtration are employed. 1300 w. Eng Rec—Oct. 15, 1898. Serial. 1st part. No. 23358.

The Essential Conditions of Bacterial Sewage Purification. A paper read before the British Assn. by W. I. Dibdin and George Thudichum. Gives the history of bacterial processes, and discusses air supply, temperature, light, reaction, time of contact, nature of bed material, and depth of bed. 3500 w. Eng Rec—Oct. 8, 1898. No. 23185.

The Septic Tank at Portadown, Ireland. Description of plant treating 22,000 gallons of sewage daily by the Exeter bacterial system. 1200 w. Eng Rec—Oct. 1, 1898. No. 23158.

Sewerage Systems.

A Comparison of the Combined and Separate Systems of Sewerage. C. P. Collins. A general discussion of systems in use, with explanation of the combined and separate systems, favoring the latter. 2500 w. Munic Engng—Oct., 1898. No. 23116 C.

Sewer Pipe.

Sewer Pipe Manufactured in England. J. A. Turner. An account of the material used and an illustrated description of the more recent methods. 3800 w. Brick—Oct., 1898. No. 23254.

Sewers.

Notes on Storm-Water Sewers. Explains the determination of their sizes and gives a diagram for estimating the rain fall for which they should be proportioned. 2200 w. Eng Rec—Oct. 1, 1898. No. 23157.

The North Carolina Avenue Concrete Sewer, Washington, D. C. Alexander Crawford Chenowith. Six illustrations of different stages of the work with description. 600 w. Stone—Oct., 1898. No. 23487 C.

STREETS AND PAVEMENTS.

Boulevards.

Parkways and Boulevards in American Cities. Sylvester Baxter. Introductory remarks upon the extensive improvements in this line in European cities, with a discussion of the drives of New York city are given in part first. 3500 w. Am Arch—Oct. 8, 1898. Serial. 1st part. No. 23252.

Curbs.

The Proper Curbing of Streets. Horace Andrews. Abstract of paper presented at meeting of Am. Soc. of Munic. Imp Mainly a description of experience at Albany, N Y. 1200 w. Eng Rec—Oct. 29, 1898. No. 23696.

Paving Brick.

What Should Be Expected of Paving Brick? Extract from a paper by F. P. Anderson, on an exhaustive series of paving brick tests, dealing also with the foundation, laying, &c. 3000 w. Clay Rec—Oct. 10, 1898. No. 23431.

Promenades.

Streets and Promenades. From *Building News* (England). Brief comparison of the streets of England and the Continent. 1400 w. Ill Car & Build—Sept. 30, 1898. No. 23261.

Street Lighting.

The Cost of Street Lighting. A statement of the method of comparing costs in different cities. Discussing facts presented in a report by N. Matthews, Jr. 1500 w. Eng Rec—Oct. 8, 1898. No. 23181.

Tree Planting.

Tree Planting in the Streets of Washington. William P. Richards. An outline of this enterprise which is under the direction of the District authorities, with facts and opinions relating to it. 2400 w. Munic Engng—Nov., 1898. No. 23700 C.

Wood Paving.

Notes on Wood Paving vs. Macadam. J. Stirrat. A statement of experiments made in Rangoon, using teak and pyinkadoe laid on a cement concrete foundation. Ill. 1000 w. Ind Engng—Sept. 10, 1898. No 23403 D.

WATER SUPPLY.

Aix-la-Chapelle.

The Extension of the Water Works of Aix la-Chapelle. (Die Erweiterung des Wasserwerkes der Stadt Aachen.) With map showing the additional sources of supply, also a discussion of the probable increased demand, and a description of the covered reservoirs used. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 17, 1898. No. 23523 D.

Croton Dam.

Progress on the New Croton Dam. Recent views of the work with report of the progress and the amount of excavation and other work already accomplished. 1500 w. Eng News—Oct. 20, 1898. No. 23458.

Dam.

Specifications for a Large Concrete Dam. Reviews the leading features of some unusual specifications for a structure to be built across the Scioto River. 900 w. Eng Rec—Oct. 29, 1898. No. 23694.

East London.

The East London Water Company. Vaughan Nash. A statement of the failure of the company to provide the district with water, the history of the undertaking, and severe criticism. 1800 w. Contemporary Rev—Oct., 1898. No. 23367 D.

Edinburgh.

The Water Works of Edinburgh. James H. Fuertes. Illustrated description of the system adopted. 900 w. Eng Rec—Oct. 29, 1898. Serial. 1st part. No 23695.

Electrolysis.

See Street and Electric Tramways.

Gas Engines.

Gas Engines for Small Water-Works. Their advantage in economy and ease of operation is discussed. 700 w. Eng Rec—Oct. 8, 1898. No. 23182.

The Gas Engine Pumping Plants of the East Pittsburg Water Company. George S. Davison. Illustrated description of works requiring a number of small pumping stations, where gas engines were found particularly useful. 1500 w. Eng Rec—Oct. 8, 1898. No. 23186.

Litigation.

The Beaver Falls Water-Works Case. Reviews a Pennsylvania decision preventing a borough from building works when it has already given a company a franchise. 700 w. Eng Rec—Oct. 1, 1898. No 23154.

Meter Tests.

Meter Testing, Somerville, Mass. Illustrated description of apparatus for water meter tests. 600 w. Eng Rec—Oct. 8, 1898. No. 23184.

Pipe Line.

The Coolgardie Pipe Line; A Remarkable Engineering Problem. Editorial discussing the project for furnishing water to this gold-mining district of Western Australia, giving extracts from the final report of the Board of Consulting Engineers. 3000 w. Eng News—Oct. 13, 1898. No. 23337.

Pitot Tubes.

Experimental Investigation of the Reliability of Pitot Tubes for Determining the Velocity of Flow of Water in Pipes. J Fraley Baker and Harvey Brett. Graduation thesis. Gives illustrated account of experiments and results 1600 w. Stevens Ind—Oct., 1898. No. 23648 D.

Plymouth.

Plymouth Water Works. Gives a brief account of the celebration in honor of the completion of the new reservoir in Dartmoor, and outline of the history of the water supply of Plymouth, Eng., with illustrations. 1700 w. Engng—Sept. 23, 1898. Serial. 1st part. No. 23148 A.

Purification Plant.

Progress on the Water Purification Plant at Albany, N. Y. An illustrated account of the present state of this interesting piece of engineering work. 1000 w. Eng News—Oct. 20, 1898. No. 23463.

Stave Pipe.

Stave Pipe—Its Economic Design and the Economy of Its Use. Arthur L. Adams. Discusses the essential considerations in stave pipe design, and some of the practical and theoretical limitations imposed. Studies several existing lines, outlines a method for making a safe and economic design, and endeavors to determine the rightful place of stave pipe in economic construction. 10,800 w. Pro Am Soc of Civ Engs—Sept., 1898. No. 23066 F.

Subaqueous Tunnel.

A Submerged Water Main Tunnel, Cleveland, O. Illustrated description of a tunnel 575 feet long, carrying a 48-in. riveted-steel pipe under a river. 1600 w. Eng Rec—Oct. 22, 1898. No. 23626.

MISCELLANY.

Assessments.

Assessment for Sewers and Water Mains. Charles Carroll Brown. Proposes a method of assessment which is in a measure proportional to the amount of use made of the system. 800 w. Munic Engng—Oct., 1898. No. 23114 C.

Garbage Disposal.

How San Francisco Disposes of Its Garbage. Compares the methods of New York and San Francisco, giving an illustrated description of the Thackeray process of incineration used by the latter city. 2000 w. Sci Am—Oct. 22, 1898. No. 23466.

Municipal Ownership.

Some Views and Data on Municipal Ownership. Henry Hopkins. States the reasons that warrant a municipal plant, and discusses why they are not usually desirable. 500 w. Elec Eng, N. Y.—Oct. 13, 1898. Serial. 1st part. No. 23316.

Municipal Reform.

The Movement for Municipal Reform. Clinton Rogers Woodruff. Reviews the ways in which reformers are working and the effort to bring them into closer relations and to increase the public interest. 3000 w. N Am Rev—Oct., 1898. No. 23208 D.

Recreation.

Gymnasiums and Playgrounds. A paper by Mayor Quincy, of Boston, read at the Social Science Convention at Saratoga. The importance of the bath, gymnasium, and playground in promoting civilization in great cities. 2500 w. San—Oct., 1898. No. 23205 D.

Smoke Prevention.

See Mechanical Engineering, Furnaces.

Washington, D. C.

The National Capital: Its Pavements and Parks, and Its Form of Government. An interesting account of the city and some of the improvements deserving attention; given in view of the annual meeting of the Munic. Improvement Society to be held in this city. Ill. 4000 w. Munic Engng—Oct., 1898. No. 23113 C.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in August. A detailed list and classified summary of accidents during August, 1898, in the United States. 4000 w. R R Gaz—Sept. 30, 1898. No. 23080.

Speeds.

Railway Speeds. W. M. A. With editorial. The writer presents arguments for and against high speed, and the editorial criticises these arguments. 3800 w. Engr, Lond—Oct. 14, 1898. No. 29612 A.

Trainloads.

Trainloads on the Northern Pacific. Important statements and figures bearing on this subject from the last annual report. 900 w. R R Gaz—Oct. 7, 1898. No. 23250.

Transport.

The Cost of Transport. (Les Prix de Transport.) A discussion of the relative cost of merchandise transport in France by rail and by canal, showing the economy of canal transport to be less than is generally supposed. 1500 w. Moniteur Industriel—Sept. 17, 1898. No. 23-565 G.

FINANCIAL.

Earnings.

Progressive Gains in Railroad Earnings. A very satisfactory report for September, with tabulated statements for comparison. 1400 w. Bradstreet's—Oct. 15, 1898. No. 23352.

Supplies.

The Purchase and Inspection of Railroad Supplies. H. B. Hodges. Extracts from a paper presented at the meeting of the N. Y. R. R. Club. Advises the purchasing of only the best quality of material. 1800 w. R R Gaz—Oct. 28, 1898. No. 23691.

LEGAL MATTERS.

Court Decision.

Joint Traffic Association Declared Illegal. The decision of the U. S. Supreme Court against the railroads, with editorial comment. 3300 w. R R Gaz—Oct. 28, 1898. No. 23687.

The Railroads and the Joint Traffic Decision. Discusses the power of Congress over railroad traffic and the effect of the recent decision of the U. S. Supreme Court. 1800 w. Bradstreet's—Oct. 29, 1898. No. 23697.

Rates.

The Fixing of Minimum Rates. Editorial

discussion of the need of legislation regulating both the maxima and minima of tariff rates. 1000 w. Ry & Engng Rev—Oct. 1, 1898. No. 23222.

MOTIVE POWER AND EQUIPMENT.

Annunciator.

A Train-Order Annunciator for Locomotive Cabs. A recording device, invented by Harry De Wallace, which warns by sight and sound when approaching a meeting point, crossing, &c., and would stop the train, if the engineer neglects his duty. Ill. 1500 w. Eng News—Oct. 27, 1898. No. 23675.

Box Car.

Northern Pacific 70,000 lbs. Capacity Box Car. Engravings showing the principal features, and also the steel truck. 1400 w. R R Gaz—Sept. 30, 1898. No. 23079.

Brakes.

Some Fine Features of the High-Speed Brake. Illustrates and discusses some ingenious features of the device. 1200 w. Loc Engng—Oct., 1898. No. 23215 C.

Car Designs.

Two New Car Designs—Northern Pacific Railway. Illustrated description of a hopper-bottom coal-car of 50-tons capacity, only 30 ft. long and weighing 35,000 lbs.; and a box car of 70,000 lbs. capacity. 1200 w. Am Eng & R R Jour—Oct., 1898. No. 23093 C.

Coupler.

A Substitute Knuckle for M. C. B. Couplers. Illustrated description of a device to be used in case of knuckle breakage, and its method of application. 600 w. Ry Mas Mech—Oct., 1898. No. 23257.

Cylinder Fastenings.

Best Fastenings for Locomotive Cylinders. Supplementary report by J. E. Sague constituting an additional discussion of this subject. Ill. 2000 w. Ry & Engng Rev—Oct. 8, 1898. No. 23306.

Derrick Car.

Derrick Car, C. M. & St. P. Ry. Illustrates and describes a new form of derrick car used in connection with the bridge erection and track elevation work on the Chicago, Milwaukee and St. Paul road. 900 w. Ry & Engng Rev—Oct. 15, 1898. No. 23433.

Equipment Painting.

Economy in Railroad Equipment Painting. Extracts from a paper by Charles E. Copp, read before the New England R. R. Club. Describes the main points of economy and the treatment now given the equipment. 1500 w. R R Gaz—Oct. 14, 1898. No. 23340.

Explosion.

Explosion of a Mountain Locomotive at Prescott, Arizona. Engravings showing the complete destruction, with brief description. 800 w. Sci Am—Oct. 8, 1898. No. 23233.

Furniture Cars.

The New 50-Ft. Furniture Cars of the Chicago, Rock Island & Pacific Ry. Some enormous cars, exceptionally large even for furniture cars, are illustrated and described. 1300 w Eng News—Oct. 27, 1898. No. 23674.

Grates.

Locomotive Grates. M. N. Forney. A discussion of grate areas and description of grate designed by the writer, but which has never been practically tested, with consideration of the question of combustion. Ill. 3300 w. Am Eng & R R Jour—Oct., 1898. No. 23090 C.

Locomotives.

A Remarkable Locomotive. Illustrated description from the "Bulletin" of the International Railway Congress, of a locomotive invented some years ago by Messieurs H. Thuile and Fouré, with a view of attaining far higher speeds than had then been reached. 500 w. Engr, Lond—Sept. 30, 1898. No. 23293 A.

A Schenectady Mogul for the New York Central. Engraving showing appearance, with dimensions and other particulars. 700 w. R R Gaz—Oct. 28, 1898. No. 23690.

Great Northern Ten-Wheel Passenger Locomotive Built by Brooks Locomotive Works of Dunkirk, N. Y. Illustrated description and principal dimensions of what is claimed to be the heaviest passenger engine in use. 1800 w. Ry & Engng Rev—Sept. 24, 1898. No. 23054.

Narrow Gauge Locomotives — Interoceanic Railway, Mexico. Photographs and particulars of two designs built at the Schenectady works. 800 w. Am Eng & R R Jour—Oct., 1898. No. 23092 C.

New Express Engine for the North-Eastern Railway. Charles Rous-Marten. Describes a new experiment of Mr. Wilson Worsdell of the North-Eastern Railway, England. 1500 w. Engr, Lond—Oct. 14, 1898. No. 23613 A.

Ten-Wheel Engines for the Boston & Maine. Engraving and descriptive specifications of freight engines recently ordered. 600 w. R R Gaz—Oct. 21, 1898. No. 23474.

Ten-Wheel Passenger Locomotives for the Fitchburg. Engraving and principal dimensions of engine guaranteed to haul a train of 325 tons up a 60-ft. grade 10 miles long, at a speed of 40 miles an hour. 200 w. R R Gaz—Oct. 21, 1898. No. 23476.

Ten-Wheel Passenger Locomotives — Great Northern Railway. Illustrated detailed description with chief dimensions of locomotives built at the Brooks works, Dunkirk, N. Y. 1500 w. Am Eng & R R Jour—Oct., 1898. No. 23091 C.

Tests of the New 10-Wheel Locomotives of the Great Northern. An account of tests giving general results and sample indicator diagrams taken. 1200 w. R R Gaz—Oct. 14, 1898. No. 23338.

The Largest Locomotive Ever built. Illustrated description of a consolidation locomotive built for the Union R. R. Co. of Pittsburg, Pa., by the Pittsburg Locomotive & Car Works. 1200 w. Eng News—Oct. 27, 1898. No. 23673.

The Locomotives of the Belgian State Railways. (Les Locomotives des Chemins de Fer de l'Etat Belge.) M. Morizot. An illustrated description of the engines shown at the Brussels-Tervueren exhibition, giving details and elevations, together with comments on the peculiarities of Belgian locomotives. 8000 w. 3 plates. Rev Gen des Chemins de Fer—Oct., 1898. No. 23536 F.

Pile-Driver Car.

Pile-Driver Car, L. S. & M. S. Ry. Detailed drawings with brief description. 600 w. Ry Mas Mech—Oct., 1898. No. 23256.

Poling Car.

Standard Poling Car; Pennsylvania R. R. Illustrates and describes the latest type of poling car, explaining its use. 700 w. Eng News—Oct. 13, 1898. No. 23335.

Resistance.

Train Resistance. Letters to the editor taking exception to previous editorial on this subject, with an editorial reply. 2500 w. Engr, Lond—Sept. 23, 1898. No. 23143 A.

Side Bearings.

Side Bearings for Cars. A. M. Waitt. Letter to the editor giving the writer's views. 1000 w. Am Eng & R R Jour—Oct. 1898. No. 23094 C.

Testing.

A Scheme for Testing Locomotive Boilers in Fast Express Service in Comparatively Short Runs. Howard H. Maxfield. The scheme described is the result of a series of tests of engines on the fast express service between Jersey City and Philadelphia, dealing only with the boiler part of the locomotive. 3800 w. Stevens Ind—Oct., 1898. No. 23649 D.

Trucks.

Car Truck Construction. Extracts from a paper by J. C. Barber, read at the Sept. meeting of the Northwest Railway Club. Advocates the diamond frame or arch-bar type. 2000 w. R R Gaz—Oct. 21., 1898. No. 23477.

The Single vs. the Double Truck Car. A letter from J. Hector Graham, taking exceptions to some of Mr. McCulloch's views. 1600 w. Elec, N. Y.—Sept. 28, 1898. No. 23072.

NEW PROJECTS.

Chinese Railroad.

The Chinese Eastern Railroad. M. Sergey Friede. An interesting account of the rapid growth of towns and cities along this route, the richness of Manchuria, the scope of the Siberian railroad, and the vastness of the enterprise. Ill. 2500 w. R R Gaz—Sept. 30, 1898. No. 23078.

East Africa.

The German East-African Central Railway. (Die Deutsch-Ostafrikanische Centralbahn.) H. von Schwabe. With profiles, data of cost, and general details of the programme. 2500 w. Glaser's Annalen—Oct., 1898. No. 23541 D.

Location.

The Technics of Railway Location. (Technische Tracirung.) Franz Hafferl. Devoted especially to the location of tramways, and local railways, with detailed descriptions of the Tichy-Starke Tachymeter. 4000 w. Mitt d Ver f d Förd d Local u Strassenbahwesens—Sept., 1898. No. 23575 E.

New Zealand.

New Zealand Railways. Information from the report of A. J. Cadman, the Present Minister for Railways, showing a most satisfactory year's working. 1200 w. Transport—Sept. 16, 1898. No. 23048 A.

Pike's Peak.

The Pike's Peak Railway. An illustrated account of this railway to the summit. It is built upon the Apt system. Also describes the equipment. 1500 w. Ry Age—Sept. 30, 1898. No. 23212.

Pioneer Construction.

Pioneer Railway Construction in New Countries. Editorial discussion of this subject, with special reference to China. Advises a cheap construction which will greatly reduce the cost of transit, executed through a large extent of country in the shortest possible time. 3000 w. Eng News—Sept. 29, 1898. No. 23075.

PERMANENT WAY, BUILDING AND FIXTURES.

Block Working.

Three Lessons from England. Editorial discussion of investigations of accidents given in the last British Board of Trade report, which show the difference between American and English practice. 3600 w. R R Gaz—Oct. 7, 1898. No. 23251.

Dresden.

The Railway Stations in Dresden. (Die Bahnhofsanlagen in Dresden.) H. Von Köpcke. A description of the new passenger station at Dresden; also the new goods station, yards, bridge, and general terminal details. 6000 w. 2 plates. Zeitschr d Ver Deutscher Ing—Oct. 8, 1898. No. 23530 D.

Inundated Districts.

Railway Construction in Districts Subject to Inundation. A discussion of the subject appearing to prove the economic value of the low-level system in spite of short interruptions to traffic. 2000 w. Eng News—Sept. 29, 1898. No. 23076.

Light Railroads.

The High Cost of Light Railroads in England. W. M. Acworth. Does not consider that light railways are likely to prove remunerative undertakings, unless their capital cost can be brought down. 700 w. R R Gaz—Sept. 30, 1898. No. 23077.

Mexico.

The Mexico, Cuernavaca and Pacific Railroad. H. W. Reed. A letter to the editor describing engineering construction, equipment and operation of the highest order. 800 w. R R Gaz—Oct. 7, 1898. No. 23249.

Omaha.

The New Burlington Station at Omaha, Neb. Illustrated description of a substantial building of brick and stone, well adapted to its intended use. 500 w. Ry Age—Sept. 30, 1898. No. 23211.

Rails.

Stresses in Rails Under Moving Loads. Records made during the hot weather of June and July with the "stremmatograph" devised by P. H. Dudley, with discussion. 4500 w. R R Gaz—Oct. 21, 1898. No. 23475.

Rail Splice.

A New Rail Splice and an Anti Creeper for Steam Railway Tracks. Illustrated description of the device for preventing rails from creeping, designed by A. Bonzano. 800 w. Eng News—Oct. 20, 1898. No. 23459.

Shops.

The Omiya Shops of the Nippon Railway of Japan. W. C. Tyler. Diagram and description of carefully planned shops, the finest in the Far East. 1200 w. Ry & Engng Rev—Oct. 1, 1898. No. 23221.

Signals.

The Thomas Stand, for Switch and Distant Signal. Illustrated description of a stand which has a spring connection with the points at all times and a stiff connection while the points are being thrown. 800 w. Ry & Engng Rev—Oct. 8, 1898. No. 23305.

Sleepers.

Comparative Experiments with Iron Sleepers. (Vergleichende Versuche mit Eisernen Querschwellen.) Ch. Renson. Report of tests made on the Liége-Limburg railway for the past 17 years, with illustrations of the most satisfactory type. 4000 w. Stahl und Eisen—Sept. 15, 1898. No. 23562 D.

Report on the Testing of Metallic Sleepers on the Liége-Limburg Railway. Ch. Renson. A very complete series of tests, lasting over 17 years, conclusively showing the advantages of metallic sleepers over those of oak. 8000 w. Bulletin Int Railway Congress—Sept., 1898. No. 23538 H.

Stations.

The Great Railway Stations of England. Thomas Cargill. The second paper contains many views and plans of important stations, with comments on the construction and arrangement. 4000 w. Engineering Magazine—Nov., 1898. No. 23592 B.

The New Station and Yards at Nashville. Plan showing the proposed arrangement as revised, and the portion of the work that will be done immediately, with brief description. 700 w. R R Gaz—Oct. 28, 1898. No. 23688.

See Architecture and Building, Heating.

Superintendent.

The Superintendent of Bridges and Buildings. Onward Bates. Lecture delivered before the students of the College of Mechanics and Engineering, Univ. of Wisconsin, 1898. Discussing the personality, duties, responsibilities, education and experience he should possess. 10,500 w. Bul of Univ of Wis—No. 26. No. 23321 C.

Tamping.

Recent Experiments in Tamping Track by Compressed Air. F. R. Coates. Read before the New England Roadmasters' Assn., Boston. Remarks the lack of progress made in surfacing track, and reviews some recent work in the use of the air blast. 3300 w. Compressed Air—Oct., 1898. No. 23204.

Turntable.

Electric Capstan and Turntable Gear; Northern Railway of France. Illustrated detailed description. 1200 w. Engng—Oct., 7, 1898. Serial. 1st part. No. 23417 A.

Electric Turntable for the Erie Railroad. Describes an installation at Jersey City, which is in effect, a small drawbridge, the essential difference being that the table seesaws over the center. Illustrations and editiorial. 2000 w. R R Gaz—Oct. 14, 1898. No. 23341.

STREET AND ELECTRIC TRAMWAYS.

Berlin Railways.

The Metropolitan and Belt Railways of Berlin. Abstracted from the *Revue Generale des Chemins de Fer*. Illustrated description. 1700 w. Eng News—Oct. 6, 1898. No. 23245.

Boston Subway.

The Completion of the Boston Subway and New Arrangements of Street Cars. States the alterations in plans made necessary by new developments in connection with the Boston Elevated Railway. Describes the stations, stairways, and other interesting particulars. Ill. 2800 w. R R Gaz—Oct. 21, 1898. No. 23478.

Bradford.

Bradford Municipal Electric Tramways. Illustrated detailed description of the road and its equipment. 3400 w. Ry Wld—Oct. 13, 1898. No. 23450 A.

Brakes.

The Use of Electric Brakes on Tramways. (Ueber die Verwendung Elektrischer Bremsen beim Strassenbahn Betriebe.) Especially illustrating and describing the Siemens & Halske magnetic brake. 800 w. Mitt d Ver f d Förd d Local u Strassenbahnwesens—Sept., 1898. No. 23576 E.

Brussels.

Brussels' Electric Railways. Illustrates and describes the conduit trolley lines recently built. 1000 w. W Elect'n—Oct. 8, 1898. No. 23260.

Chicago.

Council Report on the Street Railways of Chicago. Discusses the report of the committee appointed by the city council to investigate the street railways, their franchises, financial operations, traffic conditions, and the wages paid to employees. 2700 w. Eng News—Oct. 20, 1898. No. 23461.

Conduits.

The Siemens & Halske System of Underground Conduits for Electric Roads. Gustav Braun. Abstract translation from the *Elektrotechnische Zeitschrift*. Illustrates and describes the system in use in Germany and Austria. It differs from American practice and has ingenious features of interest. Also editorial. 2500 w. Elec Wld—Oct. 15, 1898. No. 23327.

Cripple Creek.

Cripple Creek District Railway. Illustrates and describes a road which has adopted the three-phase system with current generated at high pressure, transmitted, reduced and converted. The source of power is the flow from the different watersheds of Pike's Peak. 1700 w. St Ry Rev—Oct. 15, 1898. No. 23452 C.

Electric Traction.

Notes on the Electric Traction of Trains in the United States. (Notes sur la Traction Electrique des Trains aux Etats-Unis.) An interesting paper containing the observations of a party of engineers of the Orleans Railway Company during a recent visit of inspection in America. 10,000 w. Rev Gen des Chemins de Fer—Oct., 1898. No. 23535 F.

Electrolysis.

Electrolysis of Water Mains in Dayton, Ohio. Describes the state of 46,000 ft. of pipe costing $77,000. 1200 w. Eng Rec—Oct. 22, 1898. No. 23623.

Glasgow.

Electric Traction in Glasgow. Illustrates and describes the first electric tramway constructed in Glasgow, giving interesting particulars. 3800 w. Ry Wld—Oct. 13, 1898. No. 23451 A.

Jungfrau.

The Jungfrau Electric Railway. Illustrated description of this great work in Switzerland. 1500 w. Elec Wld—Oct. 15, 1898. No. 23325.

London.

The Waterloo and City Railway. W. B. Paley. Information concerning the operation and equipment of this road. 1000 w. Mech Wld—Sept. 23, 1898. No. 23223 A.

Measurements.

Watt-Hour Measurements on the Motive Power of the Berlin Charlottenburg Tramway. (Wattstundenmessungen an den Betriebsmitteln der Berlin-Charlottenburger Strassenbahn.) Max Schiemann. A very full account of tests made on an accumulator system, measuring the watt-hours used, and also the capacity of the accumulators. 5000 w. Elektrotech Zeitschr—Oct. 6, 1898. No. 23551 B.

Mountain Railway.

Mount Lowe Electric Mountain Railway. Olaf Ellison. Illustrates and describes a scenic railway in California. 2000 w. Sci Am—Oct. 29, 1898. No. 23668.

New York.

Reconstruction of New York Street Railways. Some facts regarding the recent improvements, and their cost, the magnitude and merit of the work, &c. 1000 w. Sci Am—Oct. 22, 1898. No. 23465.

Public Relations.

The Relation between the Public and Street Railway Companies. J. T. Little, Jr. Read before the Street Ry. Assn. of the State of N.Y. An article showing in a rather amusing way the demands of the people, and the efforts of the company to meet these demands. 3000 w. St. Ry Rev—Oct. 15, 1898. No. 23453 C.

Storage Batteries.

A Study of the Storage Battery Performance on the South Side Elevated Railroad of Chicago. J. R. Cravath. Considers the uses and performance of the battery installed. 1800 w. Elec Eng, N. Y.—Oct. 13, 1898. No. 23319.

The Storage Battery Auxiliary of the Brunswick Traction Company. Illustrates and describes a storage battery sub-station in use on a New Jersey line and found very satisfactory. 1000 w. Elec Wld—Oct. 29, 1898. No. 23666.

Surface Contact.

Electric Traction by Surface Contacts. S. P. Thompson and Miles Walker. Paper read before the British Assn. Reviews the systems based upon this principle and describes some of the methods of operation, giving illustrations. Also describes an experimental line constructed by the writers in England. 3600 w. Elect'n, Lond--Sept. 30, 1898. No. 23270 A.

Suspension Railroad.

An Electric Suspension Railroad. Brief illustrated description of a road in process of construction in Prussia. 300 w. Sci Am Sup—Oct. 15, 1898. No. 23347.

Three-Phase.

Three-Phase Current Tramway at Evian les-Bains.) Tramway à Courant Triphase d'Evian-les-Bains.) An illustrated account of this first three phase current tramway in France, with a profile of the road, and a scheme of the wiring. 1800 w. La Revue Technique—Sept. 25, 1898. No. 23507 D.

Three-Phase Railway at Evian-les-Bains. From *La Revue Technique* and *L'Industrie Electrique*. Describes an interesting short line, established to connect the hot baths with the Grand Hotel des Bains. Ill. 1600 w. Elec Eng, N. Y.—Oct. 20, 1898. No. 23441.

Trolley.

The Installation of Overhead Electric Trolley Wires. (L'Etablissement 'des Lignes Aériennes de Tramways Electriques) A very complete mathematical discussion of the stresses in overhead trolley wires, taking into account the action of gravity, wind, and changes of temperature. 6000 w. La Revue Technique—Oct. 10, 1898. No. 23513 D.

Underground.

Underground Conductors for Eelectric Railways. (Die Unterirdische Stromzuführung für Elektrische Bahnen.) G. Braun. A very fully illustrated description of the Siemens & Halske system as used at Budapest and elsewhere. 3500 w. Elektrotech Zeitschr—Sept. 22, 1898. No. 23546 B.

Vienna.

The Ringstrasse-Prater Electric Tramway in Vienna. (Die Elektrische Betriebene Tramway Ringstrasse—k k. Prater in Wien.) With map of the city, and details of track and cars. The combination of overhead trolley and storage battery is used. 3500 w. Mitt d Ver f d Förd d Local u Strassenbahnwesens—Sept., 1898. No. 23577 E.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Marine Iron Works, Incorporated, Chicago, Ill., U. S. A.=Catalogue of marine engines, boilers and general marine machinery, including single screw, twin-screw, side-paddle, and stern-wheel designs. Handsomely illustrated, and giving many useful details.

Gates Iron Works, Chicago, Ill., U. S. A.= General catalogue of mining machinery; milling, crushing, and power plants. A particularly beautiful specimen of typography, containing, in addition to illustrations of the products of the works, views of celebrated mills in various parts of the world.

B. F. Sturtevant Co., Boston, Mass., U. S. A.= Special pamphlet of the Sturtevant patent steam hot-blast apparatus, giving illustrations of the application of the system to a great variety of requirements.

W. W. Oliver, Buffalo, N. Y., U. S. A.=Catalogue of fine machinery, tools, and specialties for manufacturing jewelers, machinists, amateurs, etc., with many illustrations of high-grade tools for small work.

Wolverine Motor Works, Grand Rapids, Michigan, U. S. A.=Illustrating and describing the "Wolverine" gas and gasoline motors as especially adapted to launches and other boats. Illustrations of stationary motors and a plantation locomotive are also given.

San Francisco Bridge Company, San Francisco, Cal., U. S. A. New York Dredging Company, New York.=A very handsomely illustrated catalogue showing works completed and under construction by these companies, including piers, lighthouses, bridges, canals, and harbor works.

Meadville Vise Co., Meadville, Pa., U. S. A.= Large pamphlet catalogue of Barrett's horizontal cylinder boring machines, and of vises of all kinds.

George W. Lord, Philadelphia, Pa. U. S. A.= Essays upon Boiler Incrustation and Corrosion. A discussion of Lord's boiler compounds, and their applicability to various feed waters, as well as the causes of incrustation and corrosion.

Continental Iron Works, New York.=Handsomely bound catalogue of the Morison suspension furnaces, furnace fronts and doors for internal furnace tubular boilers. With formulas and tables showing working pressures and thicknesses of suspension furnaces, together with full working drawings of internal furnace boilers from 75 to 300 horse power.

Geo. V. Cresson, Co., Philadelphia, Pa., U.S.A. =Catalogue of power transmitting machinery, shafting, and appurtenances; including a full price list of balanced pulleys. The improved system of vertical shaft transmission is also shown, and a line of rope transmission and mill gearing, as well as hangers, couplings, &c.

John Grundy, 30 Duncan Terrace, City Road, London.=(*a*) Four page pamphlet setting forth the merits of the "Helios" smoke-consuming grate and the "Hestia" ventilating stoves; (*b*) sixty-page pamphlet containing testimonials from users of Grundy's warm air heating system.

W. N. Nicholson & Sons, Ltd., Newark-on-Trent, England.=Catalogue and price list of agricultural machinery, including grinding mills, shredders, flour, and rice machinery. Very fully illustrated, with complete descriptions of the machines. Paper cover.

Marshall Sons & Co., Ltd., Britannia Iron Works, Gainsborough, England.=Well printed catalogue of steam engines, boilers, saws, and other machinery. Many fixed and portable types are described, including traction and hauling engines.

Turner Bros., Cambrian Iron Works, Newtown, North Wales.=(*a*) Leaflet describing a timber cross cutting machine; (*b* two cards describing saw-filing, planing, and slate sawing machines.

Lawrence Scott & Co., Gothic Works, Norwich, England.=Two small price lists of the "Norwich" dynamos and electric motors, with full dimensions, weights and prices.

J. D. F. Andrews & Co., Ltd., Putney Bridge Station, Fulham, London.=Price-list of "concentric" wiring conductors, joints, and sockets; also of fuse boxes, switch boards, electric light fittings, and ventilated resistances.

The Hancock Inspirator Company, Old Swan Wharf, London Bridge, London.=Catalogue of the Hancock Inspirators, with sizes, prices, and capacities.

Siebe, Gorman & Co., Westminster Bridge road, London.=Handsomely illustrated catalogue of diving apparatus, divided into three main parts: (1) specifications of diving apparatus; (2) list of separate parts of diving apparatus; (3) illustrated supplement of some notable submarine operations.

T. Ledward & Co., 35 Queen Victoria street, London.=Descriptive pamphlet on Ledward's patent evaporative condenser for steam engines, with illustrations and list of users.

Anti-Attrition Metal Co., Ltd., Emerson street, Southwark, London.=Price-lists, with testimonials of the anti-attrition metal Nos. 1 & 2, and of Babbitt's anti-friction metal.

H. Munzing, 199 Upper Thames street, London, E. C.=(*a*) catalogue, in French, of valves, steam fittings, vices, wrenches, etc.; (*b*) pamphlet describing the Howard Thermostat, or heat regulator; (*c*) circular relative to the Stillson wrench.

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THE RELATIONS OF THE UNITED STATES TO THEIR NEW DEPENDENCIES.

By Captain A. T. Mahan.

IN modern times there have been two principal colonizing nations, which not merely have occupied and administered a great trans-marine domain, but have impressed upon it their own identity—the totality of their political and racial characteristics—to a degree that is likely to affect permanently the history of the world at large.

These two nations, it is needless to say, are Great Britain and Spain. Russia, their one competitor, differs from them in that her sustained advance over alien regions is as wholly by land as theirs has been by sea. France and Holland have occupied and administered, and continue to occupy and administer, large extents of territory; but it is scarcely necessary to argue that in neither case has the race possessed the land, nor have the national characteristics been transmitted to the dwellers therein as a whole. They have realized, rather, the idea recently formulated by Mr. Benjamin Kidd for the development of tropical regions,—administration from without.

The unexpected appearance of the United States as the legal owners of trans-marine territory, which as yet they have not had opportunity either to occupy or to administer, coincides in time with the final downfall of Spain's colonial empire, and with a stage in the upward progress of that of Great Britain, so marked, in the contrast it presents to the ruin of Spain, as to compel attention and comparison, with an ultimate purpose to draw therefrom instruction for the United States in the new career forced upon them. The larger colonies of Great Britain are not indeed reaching their majority, for

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that they did long ago; but the idea formulated in the phrase "imperial federation" shows that they, and the mother country herself, have passed through and left behind the epoch when the accepted thought in both was that they should in the end separate, as sons leave the father's roof, to set up each for himself. To that transition phase has succeeded the ideal of partnership, more complex indeed and difficult of attainment, but trebly strong, if realized. The terms of partnership, the share of each member in the burdens and in the profits, present difficulties which will delay, and may prevent, the consummation; time alone can show. The noticeable factor in this change of mind, however, is the affectionate desire manifested by both parent and children to insure the desired end. Between nations long alien we have high warrant for saying that interest alone determines action; but between communities of the same blood, and when the ties of dependence on the one part are still recent, sentiments—love and mutual pride—are powerful, provided there be good cause for them. And good cause there is. Since she lost what is now the United States, Great Britain has become benevolent and beneficent to her colonies.

It is not in colonies only, however, that Great Britain has been beneficent to weaker communities; nor are benevolence and beneficence the only qualities she has shown. She has been strong also; strong in her own interior life, whence all true strength issues; strong in the quality of the men she has sent forth, to colonize and to administer; strong to protect by the arm of her power, by land, and, above all, by sea. The advantage of the latter safeguard is common to all her dependencies; but it is among subject and alien races that her terrestrial energy chiefly manifests itself, to control, to protect, and to elevate. Of these functions, admirably discharged in the main, India and Egypt are the conspicuous illustrations. In them she administers from without, and cannot be said to colonize, for the land was already full.

Conspicuous result constitutes example; for imitation, if honorable; for warning, if shameful. Experience is the great teacher, and is at its best when personal; but in the opening of a career such experience is wanting to the individual, and must be sought in the record of other lives, or of other nations. The United States are just about to enter on a task of government—of administration—over regions which, in inhabitants, in climate, and in political tradition, differ essentially from themselves. What are the conditions of success?

We have the two great examples. Great Britain has been, in the main, and increasingly, beneficent and strong. Spain from the very first, as the records show, was inhumanly oppressive to the inferior races; and, after her own descendants in the colonies became aliens in habit to the home country, she to them also became tyrannically exacting. But, still more, Spain became weaker and weaker as the years passed, the tyranny of her extortions being partially due to exigencies of her political weakness and to her economical declension. Let us, however, not fail to observe that the beneficence, as well as the strength, of Great Britain has been a matter of growth. She was not always what she now is to the alien subject. There is, therefore, no reason to despair, as some do, that the United States, who share her traditions, can attain her success. The task is novel to us; we may make blunders; but, guided by her experience, we should reach the goal more quickly.

And it is to our interest to do so. Enlightened self-interest demands of us to recognize not merely, and in general, the imminence of the great question of the farther East, which is rising so rapidly before us, but also, specifically, the importance to us of a strong and beneficent occupation of adjacent territory. In the domain of color, black and white are contradictory; but it is not so with self-interest and beneficence in the realm of ideas. This paradox is now too generally accepted for insistence, although in the practical life of States the proper order of the two is too often inverted. But, where the relations are those of trustee to ward, as are those of any State which rules over a weaker community not admitted to the full privileges of home citizenship, the first test to which measures must be brought is the good of the ward. It is the first interest of the guardian, for it concerns his honor. Whatever the part of the United States in the growing conflict of European interests around China and the east, we deal there with equals, and may battle like men; but our new possessions, with their yet minor races, are the objects only of solicitude.

Ideas underlie action. If the paramount idea of beneficence becomes a national conviction, we may stumble and err, we may at times sin, or be betrayed by unworthy representatives; but we shall advance unfailingly. I have been asked to contribute to this discussion something from my own usual point of view; which is, of course, the bearing of sea power upon the security and the progress of nations. Well, one great element of sea power, which, it will be remembered, is commercial before it is military, is that there be territorial bases of action in the regions important to its commerce. That is self-interest. But the history of Spain's decline, and the history of Great Britain's advance,—in the latter of which the stern lesson given by the revolt of the United States is certainly a conspicuous factor, as also, perhaps, the other revolt known as the Indian Mutiny, in 1857,—alike teach us that territories beyond the sea can be securely held only when the advantage and interests of the inhabitants are the primary object of the administration. The inhabitants may not return love for their benefits,—comprehension or gratitude may fail them; but the sense of duty achieved, and the security of the tenure, are the reward of the ruler.

I have understood also that, through the pages of THE ENGINEERING MAGAZINE, I should speak to the men who stand at the head of the great mechanical industries of the country,—the great inventors and the leaders in home development,—and that they would be willing to hear me. But what can I say to them that they do not know? Their own businesses are beyond my scope and comprehension. The opportunities offered by the new acquisitions of the United States to the pursuits with which they are identified they can understand better than I. Neither is it necessary to say that adequate—nay, great—naval development is a condition of success, although such an assertion is more within my competence, as a student of navies and of history. That form of national strength which is called sea power becomes now doubly incumbent. It is needed not merely for national self-assertion, but for beneficence; to insure to the new subjects of the nation peace and industry, uninterrupted by wars, the great protection against which is preparation—to use that one counsel of Washington's which the anti-imperialist considers to be out of date.

I have therefore but one thing which I have not already often said to offer to such men, who affect these great issues through their own aptitudes and through their far-reaching influence upon public opinion, which they touch through many channels. Sea power, as a national interest, commercial and military, rests not upon fleets only, but also upon local territorial bases in distant commercial regions. It rests upon them most securely when they are extensive, and when they have a numerous population bound to the sovereign country by those ties of interest which rest upon the beneficence of the ruler; of which beneficence power to protect is not the least factor. Mere just dealing and protection, however, do not exhaust the demands of beneficence towards alien subjects, still in race-childhood. The firm, but judicious, remedying of evils, the opportunities for fuller and happier lives, which local industries and local development afford, these also are a part of the duty of the sovereign power. Above all, there must be constant recognition that self-interest and beneficence alike demand that the local welfare be first taken into account. It is possible, of course, that it may at times have to yield to the necessities of the whole body; but it should be first considered.

The task is great; who is sufficient for it? The writer believes firmly in the ultimate power of ideas. Napoleon is reported to have said: "Imagination rules the world." If this be generally so, how much more the true imaginations which are worthy to be called ideas! There is a nobility in man which welcomes the appeal to beneficence. May it find its way quickly now to the heads and hearts of the American people, before less worthy ambitions fill them; and, above all, to the kings of men, in thought and in action, under whose leadership our land makes its giant strides. There is in this no Quixotism. Materially, the interest of the nation is one with its beneficence; but, if the ideas get inverted, and the nation sees in its new responsibilities, first of all, markets and profits, with incidental resultant benefit to the natives, it will go wrong. Through such mistakes Great Britain passed. She lost the United States; she suffered bitter anguish in India; but India and Egypt testify to-day to the nobility of her repentance. Spain repented not. The examples are before us. Which shall we follow?

And is there not a stimulus to our imagination, and to high ambition, to read, as we easily may, how the oppressed have been freed, and the degraded lifted, in India and in Egypt, not only by political sagacity and courage, but by administrative capacity directing the great engineering enterprises, which change the face of a land and increase a hundredfold the opportunities for life and happiness. The profession of the writer, and the subject consequently of most of his writing, stands for organized force, which, if duly developed, is the concrete expression of the nation's strength. But, while he has never concealed his opinion that the endurance of civilization, during a future far beyond our present foresight, depends ultimately upon due organization of force, he has ever held, and striven to say, that such force is but the means to an end, which end is durable peace and progress, and therefore beneficence. The triumphs and the sufferings of the past months have drawn men's eyes to the necessity for increase of force, not merely to sustain over-sea dominion, but also to insure timely use, in action, of the latent military and naval strength which the nation possesses. The speedy and inevitable submission of Spain has demonstrated beyond contradiction the primacy of navies in determining the issue of transmarine wars; for, after Cavité and Santiago had crippled hopelessly the enemy's navy, the end could not be averted, though it might have been postponed. On the other hand, the numerical inadequacy of the troops sent to Santiago, and their apparently inadequate equipment, have shown the necessity for greater and more skilfully organized land forces. The deficiency of the United States in this respect would have permitted a prolonged resistance by the enemy's army in Cuba,—a course which, though sure to fail, appealed strongly to military punctilio.

These lessons are so obvious that it is not supposable that the national intelligence, which has determined the American demand for the Philippines, can overlook them ; certainly not readers of the character of those to whom this magazine goes. But, when all this has been admitted, and provided for, it still remains that force is but the minister under whose guardianship industry does its work and enjoys peaceably the fruits of its labor. To the mechanical industries of the country, in their multifold forms, its new possessions propound the questions, not merely of naval and military protection, but of material development, which, first beneficent to the inhabitants and to the land, gives also, and thereby, those firm foundations of a numerous and contented population, and of ample local resources, upon which alone military power can securely rest.

THE ENGINEER AND THE POLICY OF NATIONAL EXPANSION.

By Charles B. Going.

AN epoch in history creates an epoch in literature. Manila, Omdurman, and Santiago, opening broad opportunities to civilization and industry, open also the era of immensely fuller comprehension of the place and work of the engineer. The literature of his profession must fit the scope of the times.

How wide that scope is, Captain Mahan and Mr. Hunter clearly indicate in these pages—the one writing as the highest authority on national power, the other as a most able practical engineer and exponent of industrial economics. The measure they supply is true, because it compasses the whole front of the progress in which the engineer leads. But the truth is, as yet, hardly recognized and its presentation marks an epoch. The engineer heretofore has been too often regarded exclusively as a technician, and his literature as a specialized department of technology.

The engineer is, indeed, the disciple of an exact science. He deals with principles which are as fixed and all-prevailing as the laws of mathematics—with facts as immutable as the properties of matter. He must be fertile in expedient, widely adaptive in method, resourceful under difficulty—but all these are superficials ; the fundamentals of his profession are the same always and everywhere. He rests his work upon the comprehension and mastery of forces which extend throughout the universe—which are uniform, calculable, measurable, definable. And his results are directly creative and visible.

It is, therefore, not surprising, at first sight, that the engineering profession (supposing the average, rather than the exceptional, individual to be the type) should be disposed to regard the problems of social and political economy with indifference, or should be inclined to consider them as wholly foreign to their own *metier* and should look with impatience, or even resentment, upon the attempt to establish an intimate connection between their immediate interests and the seemingly inexact philosophy of sociology and politics.

But engineering science is reasonable, even before it is exact. It must be clear, upon any further thought, that the man whose function it is to work out the material progress of society is not only interested in, but dependent upon, the solution of every economic problem which that progress presents. His profession is, above all others, a development of civilization. It is, indeed, its material and mechanical side; and, the higher the civilization, the larger his field.

All work depends for its success on two conditions—opportunity and execution. It is a very partial view which includes only the latter and neglects the former. It is an axiom that no engineering work is technically impossible; given the financial support, which constitutes the opportunity, the engineer is equal to the execution of any task—even, as Mr. Gustav Lindenthal lately said in these pages, to bridging the Atlantic. But the same support is as necessary to the simplest task of spanning a highway, and it will not be furnished to the practical man until the financier sees the present stability and future promise which constitute his opportunity.

Capital is proverbially timid. Its timidity, however, is no longer as to the ability of the engineer to plan out an enterprise, calculate its cost, and assure its triumphant completion. The fear is of uncertainty or change in economic legislation, or of disastrous political moves which will unsettle credits, disturb commerce, check industry and subvert social conditions. How can the engineer stand aloof from the things upon which, first of all, not merely the expansion, but the maintenance, of his work depends? The non-material elements (in the physical sense) are the most material to the case. An unstable foundation is much less to be feared than an unstable finance—a shifting channel far less of an obstacle than shifting economic legislation—the confinement of a cramped and difficult tunnel no hindrance in comparison with the limitations of a narrow national policy.

And the engineer's interest is no less than his fitness to participate—and more, to lead—in a wise and far-seeing solution of these questions. His mastery of the direction of physical forces carries him a long way toward the comprehension of the kindred economic forces. His whole training and practice cultivate his power to discern the actual through the superficial—to shape the present action to the ultimate, though yet unseen, end—to plan out the uncreated structure and build steadily and consistently toward it, foreseeing difficulties and needs and providing to meet them as they arise. His foresight commands the respect and trust of those who consult and retain him. His manifested skill and ability hold the confidence of those who work with and under him. He is a natural leader, and duty, qualification, and interest conjoin to call him to the widest sphere of influence and administration. So far as internal affairs are concerned, it is neither expedient nor, in his own interest, possible that his work and thought should be confined to the development and utilization of natural resources—to the opening of mines, building of roads and transportation systems, erecting houses and industrial establishments, providing for the health, comfort, and luxury of the people. All these things depend upon a stable social system, a sound industrial policy, and a constantly-widening development of the means of securing work and wealth. The tariff and currency, economic and corporate legislation, forestry and mining law, individualism and socialism—are prime factors, least of all to be ignored by the engineer or excluded from his discussion and his reading.

The engineer is no mere technician; he is the moving spirit in all material advance. His connection with all the affairs of life—private, corporate, municipal, national—grows daily wider and more intimate. To him is due the steady and rapid rise in the standard of living, the gain in security and comfort of the individual, the vast increase in production. With better sanitation, safer travel, more secure residence, and the other concomitants of progressive civilization, population is increasing at an accelerated ratio, and new problems arise.

Already some gloomy forebodings are advanced as to the exhaustion of the means of existence. The fear is far off, but the immediate logic dictates a more effective use of the wealth of the world by freer intercommunication and by fuller development of the most backward and least-contributing portions. And the most significant movement of the times is the infusion of occidental life, and especially of Anglo-Saxon vitality, into long-dormant countries.

In the new gospel of industrial awakening, the engineer is the missionary. The mechanic, not the farmer, is the modern pioneer. The hammer leads the plough into the wilderness.

Witness the march of the railway and the telegraph through the length of Africa; the extension of the line across the continent of Asia; the opening of the electrical age in Japan.

But it is not the pioneer engineer alone who reaps a reward. The introduction of civilized living, stable and honest government, and wealth-making power bring enormous benefits to the new land, and at the same time afford enormous markets, with all the advantages they imply, to the home country. Precisely the same thing is true, and preëminently so, within the engineering profession.

The majority can not, or will not, expatriate themselves; but the pioneering minority first reduce the pressure of over-competition for the home places, and next create applications for products which stimulate, to their full capacity, the domestic industries. Ships must be built, railways constructed and equipped, electric-light and -power plants provided, manufacturing and mining installations designed and prepared, structural materials exported. And the practice in the newly-developing country, and the placing of the orders for its supplies, will be governed largely by considerations of national influence and affiliation. These are matters the engineer can not afford to ignore, whether or not he ever leaves his home.

Industrial ascendency, not political power, is the animus of modern international struggles. To the barbarous idea of depleting new territory has succeeded the immensely higher and more fruitful one of enriching it, by inspiring self-cultivation, with enormous reactive benefits to the parent or protecting nation. Co-operation, not tribute, is the new conception, as much more profitable eventually as it is more moral. The statesman who directs policies, and the military leader who protects the peace and maintains the order under which alone industry can be established and bear fruit, have thus become servants and ministers of the engineer who carries on the actual wealth-making work. He is far more than an interested spectator. He is the principal whose interests are at stake. The machinery and methods of war, which he has revolutionized, have now, as their chief function, his protection in the cultivation of the productiveness of peace.

"National expansion" would be a meaningless watchword if it meant only the enlargement of territory; its significance lies in the sure enlargement of markets and the increased demand for industrial manufactures and engineering talent which have more direct, practical significance than any technical discussion. "Imperialism," as a shibboleth of aggrandized political power, might well excite opposition; its true meaning—the helpful federation of the colonies which need manufactures with the strong power which has them in abundance to supply, and with them the strong arm to protect the rising commerce—must enlist the interest and sympathy of everyone even remotely connected with engineering industries. The struggle for the "open door" would be worse than futile, if it were not for the trade which is to flow through it, enriching those who sell, those who buy, and even more surely those who plan, direct, and manage the great manufacturing establishments.

The age of military aggression is disappearing, and the engineer, no less than the statesman and the soldier, must change his functions with the times. As the diplomat is becoming more of a commercial agent, and the commander more an administrator of order than a maker of war, the engineer must advance to a more influential place in the shaping of the policies under which the productive power of the country can be most surely and steadily increased and the largest returns be secured for the worker and the leader of industry.

It is, after all, but an expansion of his functions, not a new departure. As a consultant in work involving large capital outlay, matters of finance come properly within his scope. He must be familiar with their bearings and with the influences which affect investors favorably or adversely. He is frequently called upon to remain and administer the great undertakings he has created, to pass from the technical to the commercial management of vast enterprises, and to witness the economic effects and influences of works which are well-nigh national in their scope. His whole training and habit lift him above bias or prejudice, fit him to balance fact with fact, to eliminate non-essentials, to draw correct conclusions, and to see the consequences from the premises.

He is accustomed to see long perspectives and wide horizons. Above all, his profession qualifies him to measure the intervening difficulty against the potential result, and out of the confusion of the present to foreshadow the completeness and order of the future.

The times are moving rapidly, and upon the events of the next few years—or even months—depend consequences of enduring importance to the entire world. To Germany, England, and the United States especially is the importance supreme. They stand as the three great industrial countries whose products are preëminently such as the whole world needs, and whose productive capacity is greater than their home consumption can absorb. Russia is herself an undeveloped country, needing imports rather than ready to offer exports. France has few manufactures suited to new lands.

In the great game of international politics, upon which the opening and enlightenment of so large a portion of the earth's surface depend, the engineer has more at stake than any other man living. The discussion of the great questions it presents,—the broad view of economic conditions and industrial equipment in the principal nations which may compete, but must co-operate, in the industrial awakening of the East, and the study of every politico-economical problem at home,—far from being foreign to him, is vital and essential.

Practice, on its technical side, is established and formulated. Study is by no means thereby excluded; the strenuous competition of the day demands close attention to improvement of processes, reduction of costs, and betterment of design and construction. But to this narrower, though essential, economy must be added that wider economy which realizes that the world was a workshop before it was a battlefield, and will be a workshop when the battlefield is forgotten. Nothing in the government or policy of this vast workshop is of less than extreme importance to the worker,—above all to the engineer who to-day stands first in peace, first in war, and foremost of all in his part in the maintenance and advancement of the whole human race.

" Nations, like men, are governed by their interests." These interests, wisely understood, are ably presented by Captain Mahan. They are the maintenance of peace, the extension of just and stable government, and freedom of commerce. The work which England has done in Egypt, India, and Africa has been of inestimable benefit to the world. Germany and the United States are aroused to the same sense, and all must stand together for the policy of beneficence and progress. The leaders of finance and industry realize it, and no ruler or government dares to ignore their voice in a craving for political power or military glory.

But capital works through industry. The first and the greatest reward, the closest and largest interest, are those of the engineer.

THE FIGHTING ENGINEERS AT SANTIAGO.

By Arthur Warren.

ALL war correspondents are not immune. Their susceptibility to the fever of excitement may be a qualification.

One of the feverish accounts of the sinking of Cervera's fleet began: "As the smoke from the Spanish vessels rose from behind the hills at the narrow entrance of Santiago harbor, a hurried signal from the Brooklyn was followed by a rush of the American crews to the winches, and then all the Yankee ships weighed anchor and started full-speed after the enemy."

The account was possibly graphic, but it was not true. The crews did not rush to the winches, because they were not ordered to do so; there would have been no object. The ships did not weigh anchor, because in weeks they had not dropped an anchor. They did not start at full speed, because they were not in condition.

On a modern warship all the facts of a fight are not to be seen from the bridge. There are important facts which lurk in what the word-mongers call "the bowels of the ship." Some news-seekers appear inclined to think that on the bridge and in the cabin of the commander they will find the fountains of all knowledge. Besides, it is pleasanter there than in the depths. How was it that the correspondents at Santiago omitted to mention a fact no less important than this,—that on that Sunday morning when the Spanish fleet broke out from the harbor of Santiago the American fleet was unprepared to make a quick movement of any kind in the face of the enemy?

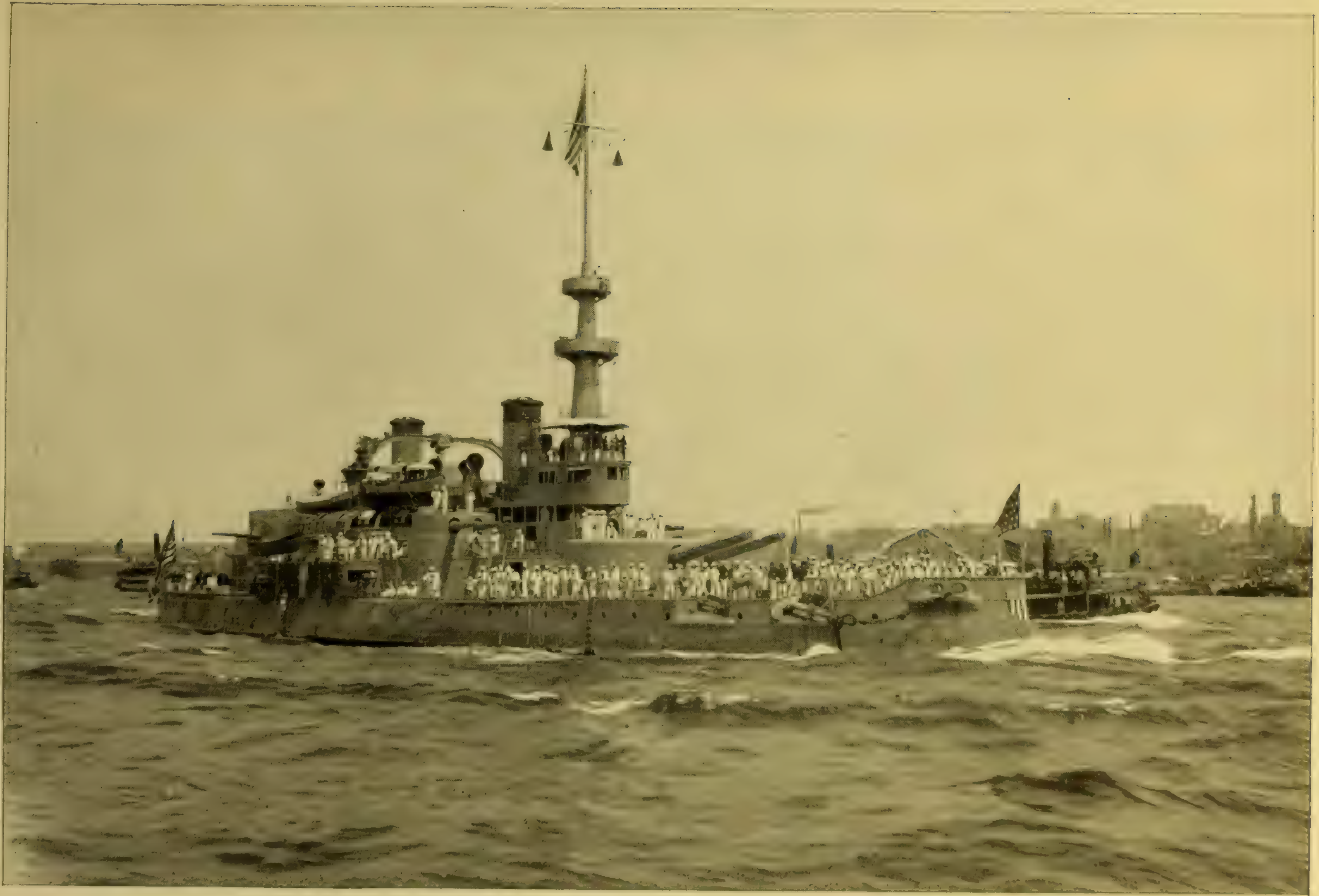
For the navy the war with Spain in American waters was an engineers' war. "The man behind the gun" gave splendid service,—none better,—and won glory for it. So much praise was used up on him that the supply was inadequate for distribution among all branches of the navy. Jackie deserved his honors. But even American warships do not move by wishing or by gun fire. The engineers put the ships where "the man behind the gun" could give an account of himself. Admirals and captains are brave enough, and keen tacticians, no doubt, but the best part of the Spanish fleet would have slipped through somebody's fingers that Sunday morning at Santiago if America's fighting engineers had not, by the hardest of work, overcome the obstacles imposed upon them by orders from the bridge. If the fighting had been against men more nearly kin—say English or German—under conditions identical with those off Santiago on the morning of July 3, some American hulks might now be rusting at the bottom of tropic seas. For engines were uncoupled, and many fires out, and steam so low that all the energy of the stokers was required to get it up again.

The American ships had been off the coast for weeks, waiting for the enemy to come out. When the enemy came out, the American ships were ready to shoot, but not to give chase. This was no fault of the engineers. It was not the effect of over-confidence. It was the result of a condition. The condition is peculiar to naval practice. It was long ago discarded in the merchant service. In the merchant service a chief engineer controls his department. In the navy the captain controls the engineers, and is in turn controlled by the commanding officer of the fleet. The chief engineer of an Atlantic liner looks to his captain for starting and stopping signals only; for the rest, he takes his orders from his owners, and reports to them. The chief engineer alone is responsible for the care, operation, and economy of the machinery. In the navy the ship's captain decides how many boilers shall be used, how much coal shall be burned, what pressure shall be carried. And the American captains at Santiago had everything in readiness, except their boilers and engines. There were two exceptions,—the Oregon and the Gloucester.

The whole world, not excepting the Spanish officers, has praised the Oregon's wonderful work — cruising and fighting. What the Oregon did other American ships could do with similar men. The Oregon's record is a tribute to the fighting engineers. It is a tribute to the good sense of the commanding officer who permitted his chief engineer to control the engines. It is a tribute to the engineer-in chief of the navy, Commodore Melville, who designed the engines. It shows the relation of the engineer to modern sea-fighting.

From Bremerton, on Puget sound, to Jupiter inlet, on the Florida coast, is 14,500 nautical miles. The Oregon steamed this distance in 1,299 hours, including stops for orders and coal; she burned 4,009 tons of coal; her highest speed was 14.6 knots, her lowest 10.159, her average 11.16. For the most part she suited her pace to that of the little Marietta, which she convoyed. She arrived at her journey's end, joined the blockade, and entered the fight without having to make a requisition for repairs.

Eternal vigilance is the price of good engines. Robert Milligan, fighting engineer, and the men under him put the Oregon where the men behind the guns could destroy the best ships of Spain. The Oregon started down the Pacific without a wartime complement of men—27 short in the engineer's force, and 67 less than her builders furnished on her trial trip. This meant work for the 94 who had to steam her to Jupiter inlet. When the ship stopped at San Francisco, at Callao, at Port Tamar, at Punta Arenas, at Rio, at Bahia, at Bar-



From Photo, Copyright 1898, by Wm. H. Rau, Philadelphia.

U. S. S. OREGON.

10,231 TONS, 5000 I. H. P.; 348 x 69.3 x 24 FT.

Twin screws; two sets triple-expansion engines; four horizontal return-tubular and two auxiliary single-ended boilers; sixteen furnaces; coal capacity, 16,000 miles at 10 knots. Four 13-inch B. L. R. in pairs in turrets; eight 8-inch B. L. R. in pairs in turrets, two on each beam; four 6-inch Q. F. R. in sponsons; twenty 6-pdr. Q. F.; six 1-pdr. Q. F.; four Gatlings; seven torpedo-tubes.

CAPTAIN CLARK, U. S. N., COMMANDING U. S. S. OREGON AT SANTIAGO.

badoes, they worked all the harder, for there was coaling to be done, and overhauling in careful haste. When the coaling was specially rapid, the officers and men of the engineer's force worked twenty-four hours on end, overhauling and adjusting, so that no minute was lost. The ship started when the bunkers were filled. There was never a minute's delay. All the cruise through, there was unremitting care. If a joint weeped, it was tightened on the instant. In the straits of Magellan the men wanted to try the forced draught. That fact is proof of their spirit. Forced-draught practice answers to General

Sherman's description of war. It is hell. Every ship in the United States service is supposed by the regulations to have a forced-draught test twice a year. Only the commander of the ship can order it. But some of the ships have never made a forced draught run since their trial trips. Perhaps the captains do not believe in it. At any rate, their men have not been trained to use it in emergency.

Milligan declined to ask the captain for permission to use forced draught. He knew that his short-handed crew were working hard enough, and half their work was still before them, and a fight at the

CHIEF ENGINEER MILLIGAN, U. S. S. OREGON.

end of it. Or the fight might come any day. But the men had caught the spirit of their chief; their pride was to keep everything in readiness. The difficulty was not to get them to work, but to prevent them from overworking. When the chief saw that they really wanted to try forced draught for the ship's sake, he persuaded the captain to let them do it. It was to them what gun-drill is to the men on the deck and in the turret. So they did it, and they did it again, and at Santiago they handled the forced draught like a plaything.

Not an ounce of salt water was allowed in the Oregon's boilers. Milligan, writing from Callao to a brother officer, said: "I fear that I am rapidly becoming the most unpopular man in the ship, because I am determined that we shall not put salt water in the boilers, and to that end have insisted to the captain that, if necessary, we must cut down the fresh water allowance for officers and men to the bare amount necessary for drinking and cooking, using salt water for bathing and all other purposes."

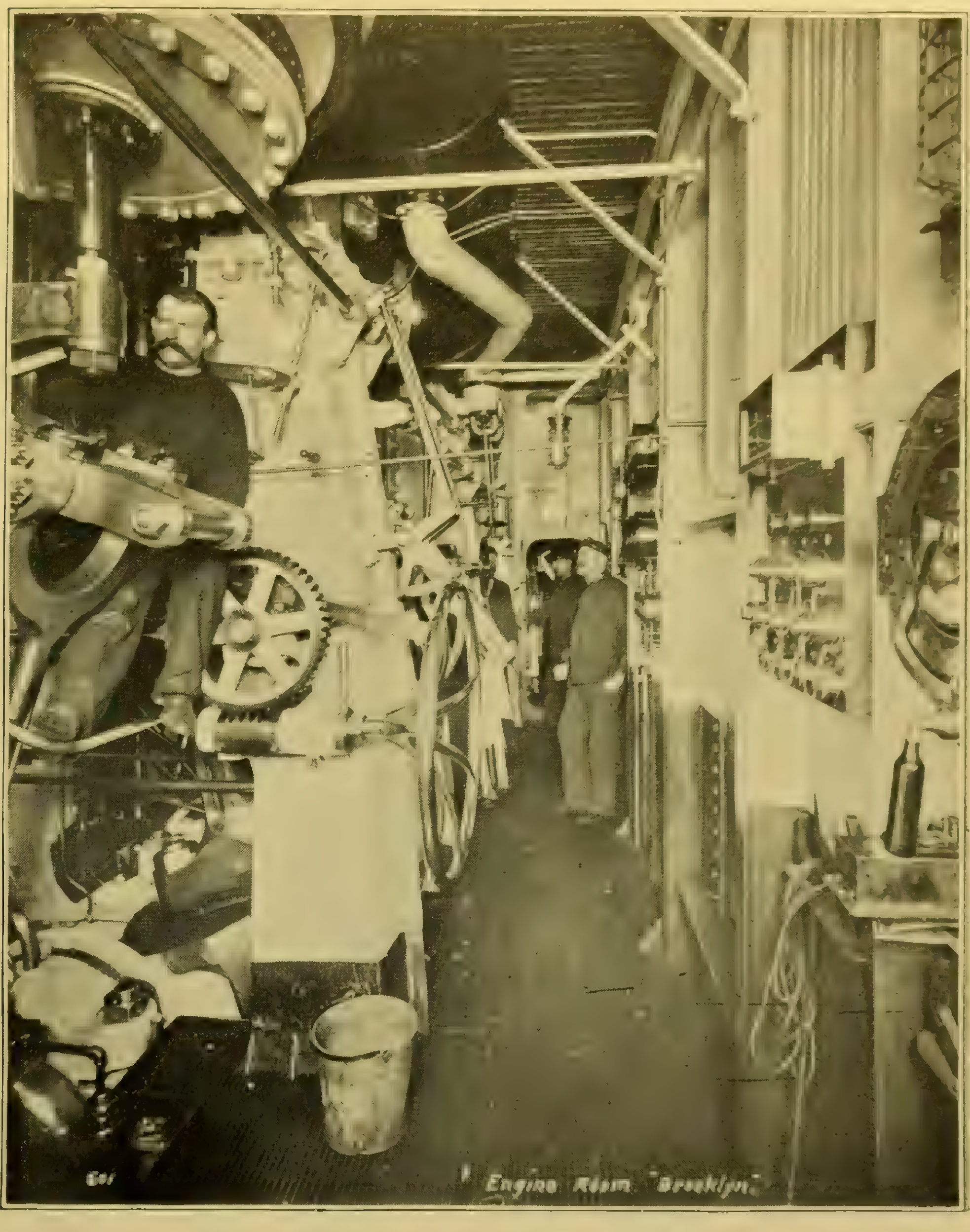
The lay mind might suppose that the object of sending the fleet to Santiago was to have it ready to jump at the enemy at the sound of the general alarm. There is a touch of the farcical in building warships, equipping them with powerful machinery, to be able, at the instant of battle, to get out of them only a fraction of their power. But somebody in authority reasoned in the fashion of Gilbertian topsy-turveydom. So the American fleet waited for the Spaniards with engines uncoupled, boilers filled (as they had long been) with salt water when they were not empty, and half the grates as clean as whistles and as cold as ice boxes.

"On the fighting ship the fighting man must stand supreme," said Theodore Roosevelt, when he was assistant secretary of the United States navy. And then he shrewdly added: "Only he must know how to handle his tools, and must change as the ship changes, so that, precisely as he once knew about sails, now he must know about engines. There can be no divided command. Only one man can exercise it; but he must be thoroughly fitted for it."

"We were caught unprepared," said one of the United States engineers at Santiago; "low fires in three boilers, others empty, and furnaces not charged."

Then there was the Brooklyn. She had five double-ended and two single-ended boilers, the equivalent of six double-ended boilers, in three water-tight compartments. She steamed from Hampton Roads to the south coast of Cuba, *via* Key West, using four boilers and four engines over the entire distance.

The commodore or the captain always designated the number of boilers and engines to be used on the Brooklyn. In practice it took



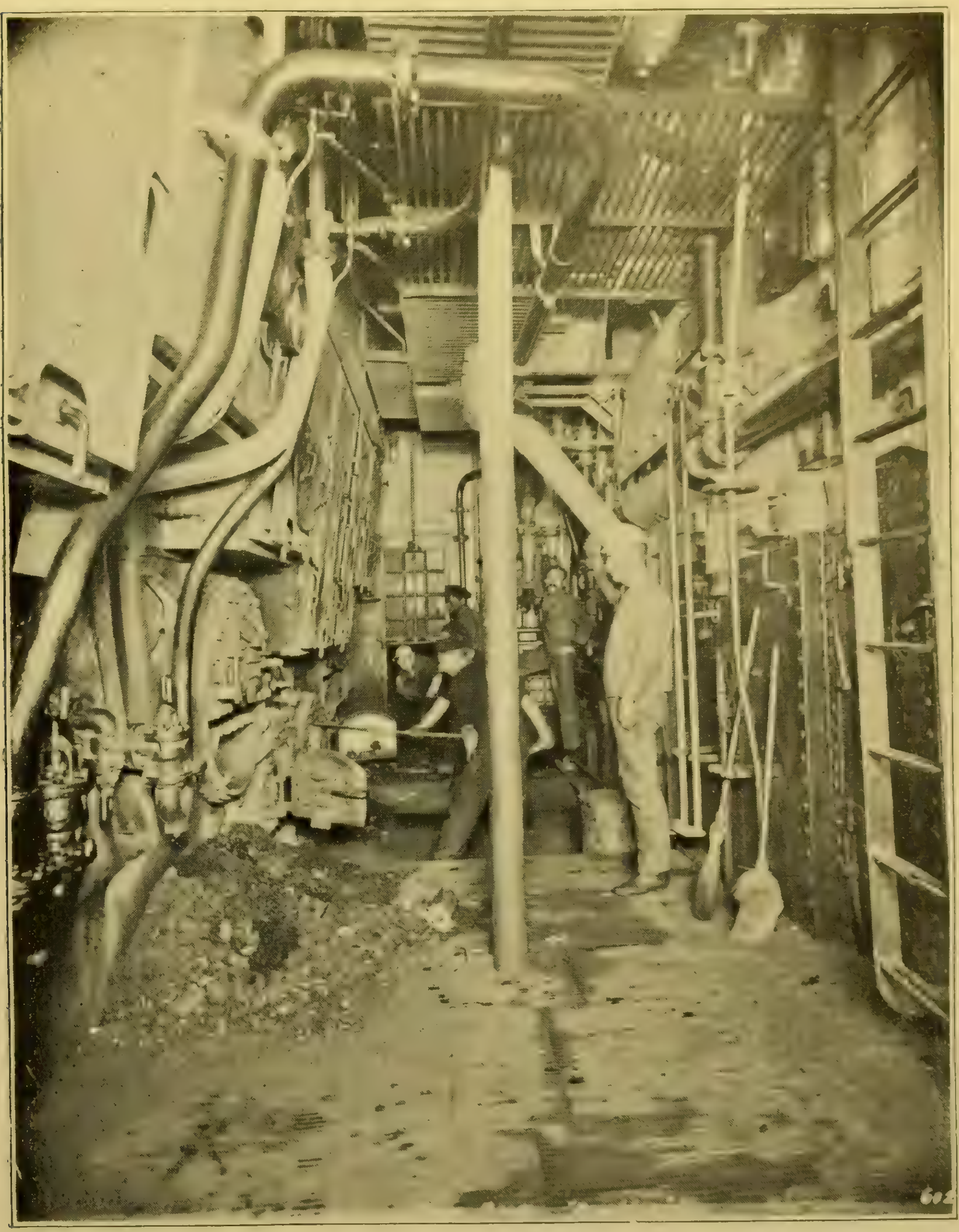
THE ENGINE ROOM OF THE U. S. BROOKLYN.

half an hour or more to couple the forward pair to the after pair of engines, and nearly an hour to uncouple them. There are no friction brakes fitted to the Brooklyn's propeller shafts, as in the case of the triple-screw cruisers; so, aboard the flagship of the "Flying Squadron," it was necessary, when coupling up the forward engines, to stop one after engine and run the other slowly for half an hour or longer, and then repeat the operation on the other side of the ship. There was another way to do it; they could stop both port and starboard engines, and then couple up!

P. A. ENGR. T. F. CARTER,
U. S. S. Brooklyn.

When there was no enemy anywhere about,— on the way from Hampton Roads to Santiago,— the flagship of the United States "Flying Squadron" had all her engines and four of her boilers in use. When she went on the blockade at Santiago, and had the enemy in touch, the flagship of the "Flying Squadron" had only half her engine power and half her boiler power ready for use. Did the bridge expect the enemy to signal: "Please connect your engines and boilers, and be good enough to light your fires. I am coming out!" Admiral Cervera was polite enough to pay the Brooklyn the compliment of his best intentions. He acknowledges that he thought her the fastest of the United States ships, and that his hope was to disable, or sink, her. Admiral Schley (commodore, as he then was) turned his ship to starboard, swung to the south, and ran seawards before taking up a parallel course with the now-retreating Spaniards. Schley is reported to have turned his ship, in order to avoid being rammed. It might be asked why he didn't do the ramming himself. But, if he had desired to do it, and if his ship had been built for it, he couldn't have managed it with only half his engine power. He had steam only in three boilers; of his remaining boilers some had water, others were empty. The interesting manœuvres of the Brooklyn will be none the less interesting, if it is found, on investigation, that standing orders from the bridge to the engine room had deprived the ship of so much of her power that she had to turn on her heel and keep at a respectful distance from the Spaniard.

After the general alarm was sounded, there was nothing for it but to fill the Brooklyn's empty boilers with sea water. Then the fires had to be laid and started. Just before the Colon surrendered,—that is, just at the end of the battle,—all the Brooklyn's boilers were steaming at maximum pressure. But the forward engines were, of course, uncoupled still. There had been no time to stop, or to slow up. The engineers had their hands full with the job of shoving the ship after the Spaniard, then pulling her away from him, and then running with him so that the man behind the gun could pump shells into him. The Brooklyn's actual running time over the 45 miles from Morro to the stranded Colon was 3 hours and 19 minutes,—a speed of 13.06 knots. And her rated speed under natural draught full power is 18 knots; under forced draught, 22 knots.



THE FIRE ROOM OF THE U. S. S. BROOKLYN.

But the Brooklyn was not the only ship caught unawares on that hustling Sunday morning off Santiago bay. Sampson's flagship, the New York, was one of the lame ducks of the fleet. The trifling distance between her eastward position and the line of the dash of Cervera was not what kept her out of the battle. Her forward engines, by orders from the bridge, were disconnected. There were boilers disconnected, empty, and, of course, fireless. Three hours after the New York started on the westward chase she had steam in all her boilers. Her engines are like those in the Brooklyn. Their condition at half-past nine that Sunday morning was precisely similar. The New York's running time, 45 miles from the Morro to the Colon, was 4 hours and 8 minutes,—a speed of 11.06 knots. Her rated speed under natural draught full power is 16 to 17 knots; under forced draught, 21 knots.

When the flagships set such seamanlike, workmanlike, fighting examples, what can be expected from the rest of the fleet? Chiefly, at the last minute, dependence on the fighting engineers to overcome needless obstacles, put the ships into position, and hold them there.

Until that morning the Brooklyn had never been under forced draught since her contract trial-trip. I have said that the service regulations require forced-draught trials at least twice a year. The regulations also provide that forced draught shall never be used, except by order of the commanding officer.

The Iowa, under orders to carry steam enough to give a seven-knot speed at night and a five-knot speed by day, was bent chiefly on coal economy. The Oregon passed her like a racer. Perhaps that is why the Oregon's erratic chaplain thought the Iowa was going in the opposite direction. The Indiana was more completely unprepared than the Brooklyn, if possible; as elaborately so as the Iowa.

The torpedo boats had a hard time in the Spanish-American war. Officers who were on them, and officers who were not on them, but who know the facts, tell truths unfamiliar to the popular ear. At the outbreak of war the number of engineer officers in the United States navy was so ridiculously inadequate to the duties required that the navy department was compelled to experiment at running torpedo flotillas with a single engineer. Not one engineer to a boat, but one engineer to six or eight boats! Young line officers had to look after the engines in the intervals of their other duties. They are not to be blamed for the defective results. They were faithful enough and ambitious enough, but you cannot learn engineering in three months.

Some of the United States torpedo-boat boilers were completely wrecked for lack of water. One of the boats burned all her boilers so badly that, when they were taken out, the workmen, the contractors, inspectors, and everybody else who saw them, were amazed at the temerity of the men who had kept steam in them. The commanding officer of one torpedo boat prepared an elaborate report on

CHIEF ENGINEER W. B. BAYLEY,
U. S. S. Massachusetts.

the constructive defects of the machinery of his craft. A judicious friend pointed out that his report really proved the mishaps in his engine-room to be due to the inexperience of the men who had been allotted to duty there.

The Oregon was not favored by position at half-past nine that Sunday morning off Santiago. She was, if anything, farther from the harbor entrance and the course of the Spaniards than the other battleships, but in the long chase her shells told the Colon that the game was up. The Colon, in spite of her poor mechanical condition, was nearly holding her own with the Brooklyn. But the Oregon, nominally of five knots' less speed, was steadily gaining. Milligan's work brought the ship into position where the man behind the gun could use his biggest armament. The Oregon was running at a rate exceeding sixteen knots. Her shots sent the Viscaya to the shore in flames. Her thirteen-inch shells compelled the Colon to surrender. Every official report paid tribute to her work. It is even officially conceded that, but for the Oregon, the Colon and probably another Spanish ship would have escaped. So much for having engines in order, boilers ready, fires burning. Here was a ship after a fifteen-thousand-mile run, four months out of dock, with foul bottom and increased displacement, almost equalling her trial-trip record for speed. And she fought as she ran. Inside of fifteen minutes after the full-speed signal was given, she was making fifteen knots. Within an hour she was making nearly seventeen.

Coming down the Pacific, the Oregon had Cardiff coal under her boilers,—the best quality of Cardiff for steaming. When she turned the corner of the continent and got into the Atlantic, she picked up in the coal-ports the best fuel she could buy, but it was much inferior to Cardiff. Milligan had a few hundred tons of Cardiff left. He shovelled them into the fighting bunkers. "This will do for emergency," said he. Then he locked the bunkers. On the blockade the coal supplied to the ships was—well, less fiery than patriotism.

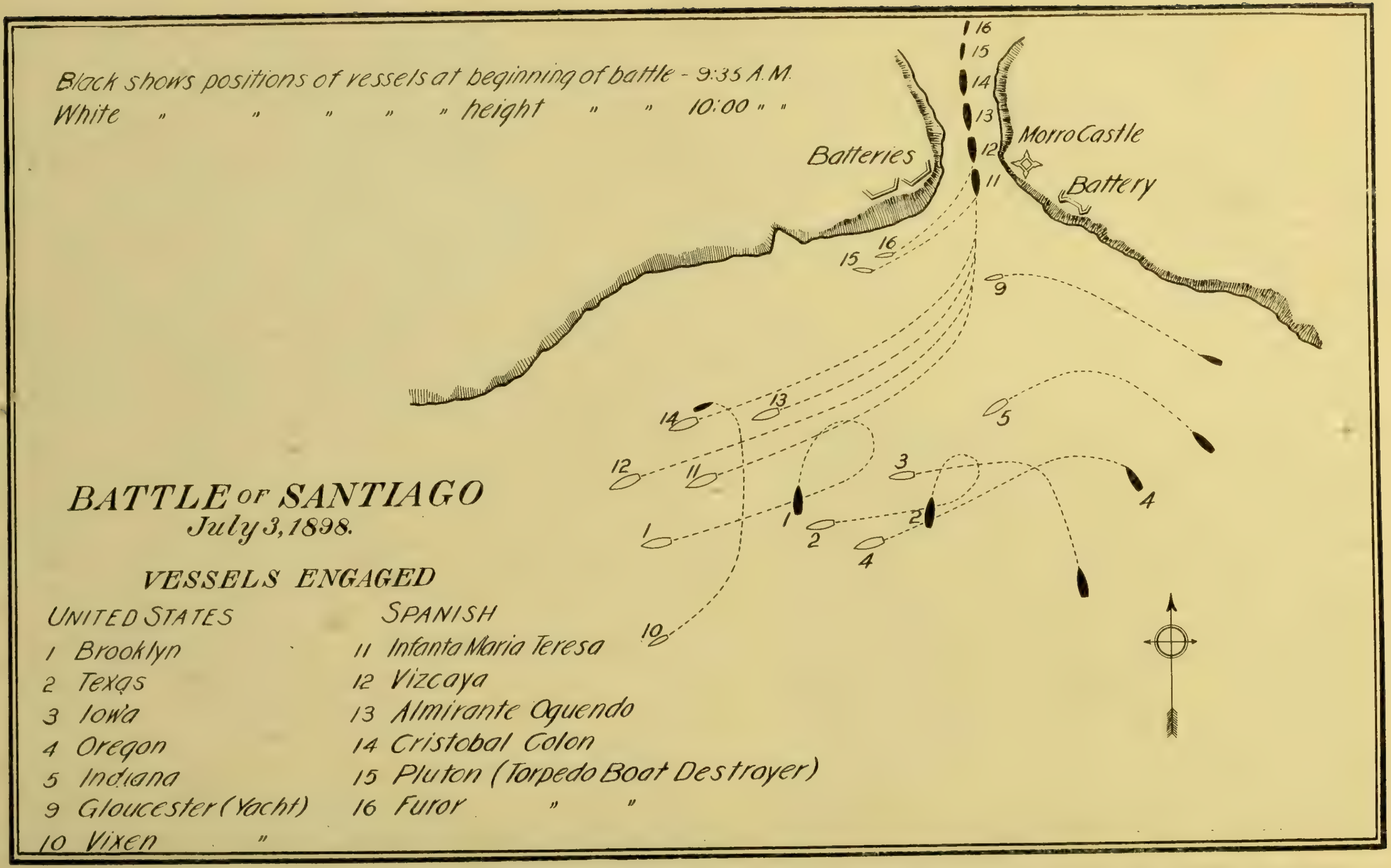


CHART SHOWING THE POSITIONS OF SPANISH AND AMERICAN VESSELS AND THEIR MOVEMENTS AT THE BEGINNING OF THE ENGAGEMENT OF SANTIAGO, JULY 3, 1898.

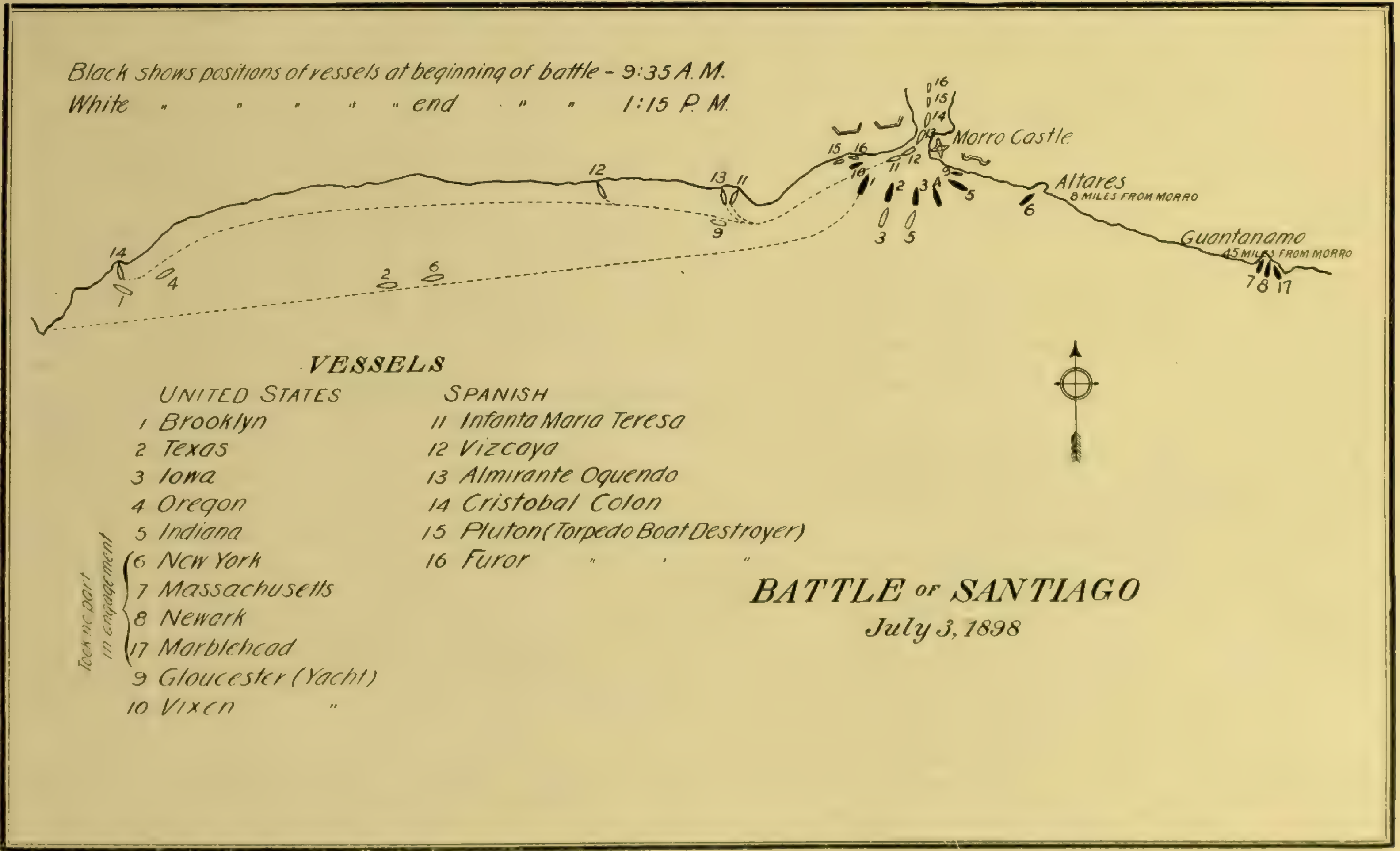


CHART SHOWING POSITIONS OF SPANISH AND AMERICAN VESSELS AT THE BEGINNING AND THE END OF THE BATTLE OF SANTIAGO.

CHIEF ENGINEER CHAS. W. RAE, U. S. N.
U. S. S. Iowa.

On the day of the battle Milligan unlocked the fighting bunkers, and the Cardiff coal helped the Oregon to make her burst of speed. Besides, there were fires under all her boilers when Cervera slipped out. "For God's sake, get on more boilers!" That was the sort of message sent from the bridge of one of the United States warships to the chief engineer, half a dozen times in an hour, when the fleet was pelting the Spaniards. The authority who in time of war had his boiler-rooms ready for peace chafed at the delay. His anxious messages were beginning to worry the men below—machinists, water-tenders, oilers, coal passers, firemen. The chief engineer stood in between, knowing that his men must keep cool-headed, and he sent back word that all the boilers were connected, filled, and all the fires burning. "It's the only way to keep the old man quiet," he said. But all the boilers were not yet connected when the fight finished.

If you were sealed up in a heated iron tank floating on the sea and hammered at by missiles which now and then let in daylight and splinters, you would get a dim idea of the lot of the engineer's men aboard a battleship in action. But the engineer's men have to work in the hurly-burly, and you would go mad in your tank. The enemy's shot pounds the ship, but the engineer and his men know not where the enemy is or where the ship is heading. And they can't stop to think about it. Keep that bearing cool, smother it in oil, drown it in water! Keep it cool, or the game's up!

P. A. ENGR. F. M. BENNETT.
U. S. S. New York.

IN THE ENGINE ROOM OF THE U. S. S. IOWA.

The men on deck can let the splinters lie where they fall, but the men in the engine room have to keep the splinters out of the machinery. Steam pipes are pierced. Mend 'em. Crawl behind the boilers, and stop that steam leak. Impossible to shut off anything. Scalded? Never mind. It's all in the day's work. Don't let the water down. Pass the coal lively. And, while you're about it, put out that fire in the bunkers. Grimy men, dripping with sweat, go about quietly, with clear heads, watching everything. There's no bawling, no usual noise, no confusion. In the lower engine-rooms the thermometer shows 136 degrees in front of the ventilating blowers; in the upper engine-rooms, 190 degrees. Men dart into the upper rooms twice an hour or so, look around for a minute or two, and then dart out again. There on the hot seas, on July 3d, the temperature above the boilers of the Texas was sometimes 200 degrees!

The fighting engineers! By old-time tradition, dating from the days when steam power was merely an auxiliary to wind power, the naval engineers are thought of as non-combatants. Ships change, and duties change. The engineer is now a combatant as truly as the man on the bridge or the man behind the gun. The modern fighting ship is a fighting machine; her efficiency depends upon the engineer.

The engineer of the merchant service has authority which the naval engineer does not possess. It is now proposed, in the United States navy, to improve on the practice of the merchant service. Enlightened opinion favors the plan for abolishing the distinction between line and staff. Engineer officers are to be officers of the line. All line officers are to be taught engineering.

CHIEF ENGINEER E. R. FREEMAN, U. S. N.
Formerly of the Nashville; now of the Indiana.

A generation hence the anomalies of the present service will have passed away. The line officer of the future will know the engine room as well as the wheel-house and the bridge, for he will serve below as well as above. Meanwhile nothing will be lost, if we remember what the fighting engineers did to save the day at Santiago.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

SPECIALIZATION VS. GENERALIZATION OF EQUIPMENT AND PRODUCTS.

THE large quantity of American machinery now being sent to European countries indicates that there is something in American machine-tool practice and design which is desirable to European manufacturers, and cannot be secured from their own makers of machinery. Why is it that the European manufacturer is buying so largely from America? How is it that the American machine-tool maker can send machinery abroad, pay freight and duty, and compete with the European maker? It is important for both sides to understand the situation: on the one hand, for the European to select that which is good in American practice, and to adopt it as far as possible; on the other hand, for the American maker of machinery to know where his practice differs from the European, so that he may adapt his methods, as far as desirable, to European demands. An attempt will be made in this and following articles to review the situation from an impartial standpoint, not to criticise one side or to unduly praise the other, but to state facts which may be of interest to both. Having had nine years' experience among European manufacturers, I do not hesitate to state that not one manufacturing establishment among ten, in either England or Germany, is properly equipped with machinery, or organized in accordance with modern methods. With exceptional opportunities for coming in contact with makers and dealers in American machinery, I have found few who understand the requirements and conditions of European manufacturers.

A word should be said here as to the importance of the "machine tool" in its relation to general manufacture, and to the place it occupies as a factor of industrial progress. It is the mother of all modern industries. Without it, interchangeable work, and the manufacture and maintenance of automatic machinery, are impossibilities. Without the backing of highly-skilled mechanics, who are developing and making efficient and accurate machine tools, the manufacturers of the United States could not hold the position they do,—a position which justifies the following statement of a leading London daily: "There is no question that the commercial interests of the United States are growing by leaps and bounds. Europe is beginning to be inundated with American goods, and American firms are getting contracts at the expense of European rivals all the world over.'' This could not be accomplished except for the fact that American manufacturing plants are maintained by the universal use of high-class machine tools operated by well-paid workmen—workmen who receive wages that are invariably considered by European manufacturers wasteful and ridiculously in excess; nevertheless, these wages are as much a necessity in Europe as in America,—perhaps more. European manufacturers do not, as a rule, appreciate the fact that high-class and accurate machine tools are necessary auxiliaries to economic production, and that, in selecting them, quality should be the first consideration. Want of understanding in this respect, on the part of both employers and employees, is one of the most serious drawbacks to progress among European manufacturers. The accurate machine tool is the stronghold of the American manufacturer. How it is made use of by the one, and neglected by the other, it is my object to explain.

In treating the subject, it will be recognised that there are exceptional cases, good and bad, in all countries. As far as American practice is concerned, special reference is made to the New England States, the acknowledged home of American machine-tool design. Among European countries, England and Germany are particularly referred to, as they are, at present, the most important to the general machine-tool market.

A modern machine shop is made up essentially of four elements:

(1) The factory organization;
(2) The equipment;
(3) The workmen;
(4) The commercial management.

In comparing European and American machine-shop methods, however, there are certain peculiarities which call for special consideration, and the above items must be sub-divided. For clearness and convenience, it is thought best to treat the matter under the following headings, which, as will be noted, include the above:

(1) Specialization and manufacturing varieties;
(2) Labor-saving machinery and low-wage workers;
(3) Environment and efficiency of workmen;
(4) Commercial conditions;
(5) Elements of a modern machine shop;
(6) Comparisons as to efficiency of machinery and methods.

To an American manufacturer visiting European machine shops, the most striking thing is the immense variety of work turned out by establishments of any size whatever. He is invariably astonished at the variety of work undertaken, even by small shops,—a variety rarely attempted by any American establishment. There are many machine shops, both in England and on the continent, that will supply complete plants of machinery, and manufacture within their own walls boilers, engines, shafting, hangers, pulleys, small tools, and all sorts of machines, both large and small. While this state of affairs may be explained historically, it cannot be defended as an economic principle, in the light of modern practice. The very opposite policy is followed by most American makers of machinery. Many concerns could be mentioned which devote themselves entirely to one line of machinery, and have no hesitation whatever in refusing business or orders for anything which they are not specially equipped for producing, and of which they have not made a special study. In a number of cases this is carried to the extreme. One firm makes nothing but turret lathes, and only one size at that. Others confine themselves wholly to the manufacture of drilling machines, or of lathes, planers, milling machines, grinding machines, etc. In fact, in America every article in the list of machine tools is receiving particular attention from specialists. The effects of this specialization are interesting and entirely in accordance with modern progress, and this one fact contributes largely to the success of the American manufacturer of machine tools in producing an article of the best workmanship and most approved design at the lowest price. As in chemistry, medicine, surgery, or any of the arts and sciences, the field in machine construction is to-day so wide that it is impossible for any one mind to grasp all the details of its different departments, or to master the immense number of facts which are being collected, and the theories which are being developed, by specialists. A natural segregation has occurred in all the arts and sciences, and the American idea of specializing in the manufacture of machine tools is but a practical application of this principle, which is being adopted in every calling. European nations must follow the same lines, if they hope to compete. We have specialists in art, medicine, law, in all professions and in many industries, why not in the manufacture of machine tools? There are, and will continue to be, conditions which call for all-round mechanical engineers, but certainly the field for such is decreasing.

It will be well to call attention to some of the good effects which specialization has on general manufacture, and to the resulting advantages which the American maker of machine tools is securing in competition with Europeans. In the first place, special engineers are being produced,—men who are confining themselves to the study of one class of machinery, and are constantly working at the design of a particular line of tools. They study to increase the capacity of these machines, to broaden the field of their application, and to make them cheaper. These special engineers are becoming a necessity to manufacturers, and they occupy to-day, in America, a recognized position as authorities in their special lines. Their standing and reputation are of commercial value to the companies with which they are connected, and are the equivalent of a good will, which is a valuable asset. The effect of their work is to develop and produce a machine best adapted to the end in view, and to make it at a price with which the manufacturer of many and varied classes cannot possibly compete. This method of working has also produced a class of expert workmen and tool makers who, by confining themselves wholly to one branch, have had the opportunity of designing special tools for the production of their class of machinery, and have become, by experience, so adept at their work as to be able to turn out machines with a high degree of accuracy, and a good finish, at a low price. Each specialist is constantly exerting himself to make his machine produce the best work, and to make improvements by which he can reduce the costs of manufacturing to his customers. He is ever on the alert to make any new application of his machine, to enable him to compete with makers of other lines.

There are many interesting examples of this specializing competition, one of which is that of the planing machine and the milling machine. A short time ago the wonderful results produced by the milling machine were proclaimed by many as the precursor of the downfall of the planing machine. To-day it seems to be fairly settled that these two machines should work in the most friendly way, and that alternate planing and milling on the same piece is, in many cases, the most advantageous way of producing good work. The planing machine is now made in America by several companies that make no other machinery; the same can be said of the milling machine. The result is that both are made better and more cheaply than ever, and the product of each is largely increased. The same contest has taken place between the turret machine and the lathe. We find work being done on the turret machine which was formerly done on the lathe, and, at the same time, better results are attained on both machines; that is to say, the lathe and the turret machine are producing the cheapest and best work by an interchange of operations.

Similar improvements are the result of the study of the grinding machine by specialists. Parts are roughed out on the lathe nearly to size, and then finished truly cylindrical, and to gauge, on the grinding machine. With this method no special skill is necessary for either operation; that is to say, no specially skilled "turner" is necessary, and exact results are attained on the grinding machine by workmen who have served no long apprenticeship.

One of the most striking results of specialization has been in the recent development of the automatic screw machine. This machine, which was originally used for the production of small parts, mostly machine screws, is now made to turn out many complicated and expensive forms. Bicycle hubs, ball handles, and complicated parts, drilled out, turned all over, and threaded, are now produced on the automatic screw machine from a bar of material, one workman attending from six to ten machines. Only a few years ago this was unthought of, or deemed impossible. The development of this class of work may be attributed wholly to specialization of talent, plant, and management.

Not only are the Americans sending abroad quantities of machines adapted to special purposes,—largely bicycle parts,—but there has also been a very large exportation from the United States of regular machine tools, such as lathes, milling machines, planers, drilling machines, etc. In the regular lines of machinery, like the above, where advantages common to special machinery are not an inducement to buy, the machine being a regularly-catalogued article, the American makers are competing with the European manufacturer. This success is also due almost entirely to specialization. Factories could be named where these results are attained through no particular superiority in design of the machine, but simply through the fact that the whole engineering and commercial staff is devoted to the production of one article. Such machines as lathes and drilling machines are turned out in lots of one hundred, and even larger quantities. Parts, such as head-stocks, tail-stocks, or slide-rests, are "jigged" like sewing-machine parts, holes being bored, drilled, and counterbored without the use of a boring mill. Smaller parts, such as hand wheels, change gears, or cone pulleys, are made in still larger quantities, and are carried in stock. All these smaller parts are made interchangeable and to gauge, and are held in readiness to be put into machines as fast as they are to be assembled. In this way machine tools are "manufactured," and the operations are largely performed by comparatively unskilled labor. How is it possible for those who make one machine to order, or make small lots, as manufacturers of a great variety of machine must do, to compete with these methods?

It should be mentioned that some results not altogether desirable are noticeable in American practice where special efforts have been made to reduce machine-tool production to a manufacturing basis. Some of the American makers have gone so far in their efforts to produce quantity that they have sacrificed quality. Machine tools can be "manufactured" up to a certain limit; beyond that they must be "made." The great bulk of machine tools can be turned out in quantities at a low cost, but the fine, accurate machinery, which is really the foundation of all good and cheap production, calls for the highest skill of the experienced workman, as well as for the finest judgment in design. The ideal machine shop is one in which the most rational methods of manufacturing are combined with the most accurate finish and thorough inspection.

In America the practice is also thoroughly established of separating the heavy from the light machine-tool manufacture. This is done by European makers, although not so extensively or effectively. No makers of note in America are producing both light and heavy machinery. On the other hand, in European countries it is the rule rather than the exception for machine-tool makers to produce both heavy and light machinery. This is difficult. The engineering problems are so different, there is such a variation in the demands of customers, and the plants and workshops best adapted for the manufacture of heavy or light machinery are so dissimilar, that the two branches cannot be worked together satisfactorily.

Some of the success of the American machine tools in the European market is undoubtedly attributable to the fact that the specialized manufacturer is largely used as a consulting engineer. European manufacturers are making extensive use of the American specialist as a source of information by which their articles can be more accurately and cheaply produced. All this consulting work is free to the customer, the machine-tool maker getting his "fees" through profits on tools supplied. In addition to the technical advantages which can be offered on account of specialization, the salesman also finds it to his benefit to make a particular study of the wants of customers, and in this way to extend the interest of all concerned. This matter will receive special attention in a later article, as it has an important bearing on the questions before us.

The practice of European as compared with that of American mechanical engineers is stated in the interesting address given by Mr. G. F. Deekin before the British Association, at its last year's meeting in Montreal. Mr. Deekin is evidently not acquainted with the latest practice in America, for, in speaking of the successful careers in the engineering profession, he remarks: "It is sometimes useful to observe these careers, and, whenever we do so, we find the very reverse of specialization." This is true, speaking broadly of the engineering profession as practiced by Europeans, but it is not in accordance with modern methods. The times are passed when an engineer, a mechanic, or any industrial or scientific worker could successfully pursue every branch of his calling. Julius Cæsar was great as a soldier, an architect, a historian, and a statesman, but such a character is impossible in the nineteenth century. No man can, at the present time, pretend to be great in all lines. The accumulated knowledge of centuries is too vast to be at the command of any one mind, and general progress is too rapid to be kept pace with by any individual worker. It is but in accordance with the times and modern requirements that machine-tool engineering, like other things, should specialize itself. Whatever the calling may be, the successful man of to day must make that calling his special study, and he can give but little attention to other lines.

With respect to the European situation, it must be admitted that specialization of manufacture in the machine-tool business is but slightly developed. Not one case of a company in Europe devoting itself wholly to one line of machine tools is known to the writer. Such companies may exist, but they certainly have neither the reputation or the standing that we find among American manufacturers of machinery. The hap-hazard practice of European machine-tool makers has a noticeably bad effect in many ways. One of the most serious is that it operates to produce indifferent workmen and designers,—men without any special training, experience, or interest in any particular line. Men who are making a steam engine or a boiler one day, working on a lathe next week, and operating a planing machine the week after, cannot be expected to have any particular interest in a special line, or any skill in making or developing that line. The results are, of course, slow progress in design, little application of improved methods, and indifferently made machinery. The evil effects are seen throughout European workshops, in their equipment and organization. Even the simplest articles cannot be properly manufactured on crudely-developed machinery. There are various conditions affecting European makers which do not, of course, influence American manufacturers. The conditions of trade are not alike, particularly as carried out by exporting houses in London, Antwerp, or Hamburg. Undoubtedly the peculiar state of the European machine-tool makers has been partly brought about by their large export trade, and the fact that they undertake to produce every article called for by foreign enquiries or indents, where complete plants are required. But no conditions can justify the present attitude of the European maker of machine tools. He must apply himself to one line, and perfect and develop that line, avoiding both general manufacturing and general trading.

EQUIPMENT, MANAGEMENT, AND ECONOMIC INFLUENCE OF THE SHIP CANAL.

By W. Henry Hunter.

TAKING, as examples of the two types of canal dealt with in these articles,* the Suez canal, exemplifying the through-road waterway, and the Manchester ship canal, exemplifying the *cul-de-sac*, the results of the construction and working of the two waterways may already be seen in measure.

Few care to remember now the scorn and derision with which M. Ferdinand Lesseps was met when he first proposed to revive the ancient project of a canal between the Mediterranean and the Red sea, and thus provide a new route from Europe to the east.

It was shewn, it was demonstrated, that from an engineering point of view the thing was impossible, simply absurd, while from a commercial point of view it was proved, up to the hilt, that, even if the canal could be made, it would, so far as traffic went, be a failure as melancholy to the philanthropist as it would be disastrous to the investor. The great authorities who spoke thus with so much assurance and in so fine a prophetic vein are all dead, and it is well for their comfort that they are. The merest school-boy to-day knows the Suez canal as one of the great triumphs of the century, and, whatever clouds may have gathered around M. Lesseps's closing days, he made the Suez canal, and will, so long as time may last, have a place among the benefactors of mankind.

In 1869 traffic *via* the Cape of Good Hope was about 3,500,000 tons. In 1897 the traffic through the Suez canal was 7,898,981 tons, while that round the Cape of Good Hope was at least 3,750,000 tons—all figures being registered tonnage, much less than actual weight.

In other words, one direct result of the construction of the Suez canal has been that in twenty-eight years the commerce of the world has been increased by some 8,000,000 tons annually.

The value of this increase to humanity cannot even be guessed at; the ramifications are too great and the effects too far-reaching.

It is hardly necessary to add that the return to the investor who risked his money in what seemed to so many to be a hare-brained project has been, to say the least of it, of a fairly satisfactory character.

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* Mr. Hunter's former article, in December, depicted the importance of the ship canal in uniting the seas which, in turn, "unite continents." He traced its enormous influence upon the effective utilisation of the world's wealth, and sketched the functions and necessary equipment of the two principal types—through and terminal.

TRAFFORD WHARF, MANCHESTER SHIP CANAL.

The Manchester ship canal differs from the Suez canal in that (*a*) it is not yet five years since it was opened to the trade of the world, and (*b*) the results of its working are of a more local character, although by them the well-being of millions of persons has been directly affected, while indirectly these results are well-nigh, if not altogether, of national import. The returns of traffic carried on the canal since its opening are as follows:

1894................	925,659	tons
1895................	1,358,875	"
1896................	1,826,237	"
1897................	2,065,815	"
First half of 1898................	1,173,880	"

Not very large figures, but larger than those of the trade through the Suez in the same respective times.

MODEWHEEL LOCK.

And, as there has been no diminution of the trade of Liverpool in the years specified,—there has been, on the contrary, a distinct increase of that trade,—the Manchester ship canal figures represent a positive addition to the commerce and an increment of the wealth of the country. Other effects are shewn by the table.

COMPARISON OF RAILWAY RATES

Before the passing of the Manchester Ship Act, 1885, with those of the present time.

STATIONS BETWEEN	Description of Traffic.	1884.			1898.		
		s.	d.		s.	d.	
Liverpool and Manchester	Cotton.................. ..	8		S to S	7	2	S to S
	Grain	7	4	4 tons collected	6	11	4 tons collected
	Timber..................	7	6	“ “	6	8	“ “
	Pig Iron.................	5 6	9 4	British Foreign	4	2	S
	Sugar....................	6	8	2 tons S S	6	8	5 tons S S
	Machinery	9	2	S to S	9	2	S to S
	Bacon and Hams (packed)	10		“	9	2	“
	Dyewoods (class 1)......	8		“	7	11	“
	Iron and Steel (class c)..	6	8	“	5	10	2 tons S to S
Liverpool and Stockport	Cotton....................	8		“	7	2	S to S
	Grain.............	7	4	4 tons collected	6	11	4 tons collected
	Timber.............. ..	7	6	“ “	6	8	“ “
	Pig Iron.................	6	3	S S	4	4	S S
	Sugar	6	8	2 tons S S	6	8	5 tons S to S
	Machinery...............	9	2	S to S	9	2	S to S
	Bacon and Hams (packed)	10		“	9	2	“
	Dyewoods (class 1)......	7	6	“	7	11	‘
	Iron and Steel (class c)..	7	6	“	6	8	4 tons S to S
Liverpool and Staleybridge and Ashton	Cotton.	11	3	“	10	5	collected
	Grain....................	8	2	4 tons collected	7	9	4 tons collected
	Timber.......	8	4	“ “	7	6	“ “
	Pig Iron	5	2	S S	4	5	S S
	Sugar	10		2 tons S to S	7	6	5 tons S to S
	Machinery (in cases) .	11	8	S to S	10	10	S to S
	Bacon and Hams (packed)	11	8	“	10	10	“
	Iron and Steel (class c)..	8	4	“	6	3	2 tons S to S
Liverpool and Bolton	Cotton.....	8	4	collected	8		collected
	Grain................	8		C and D	7	11	C and D
	Timber.	6	10	S to S	6	6	S to S
	Pig Iron.................	5	5	S S	3	8	S S
	Sugar	9	2		9	2	collected
	Machinery (in cases)	10		carted	7	6	S to S
	Bacon and Hams........	10			10		collected
	Iron and Steel (class c)..	7		S to S	5	10	S to S
Liverpool and Bury	Cotton	9	2	“	8	4	“
	Grain....................	8	3	collected	7	6	4 tons collected
	Timber..................	9	2	“	7	3	“ “
	Pig Iron.................	5	6	S S	4	5	S S
	Sugar....................	10	10	S to S	8	4	10 tons S to S
	Machinery...............	11	8	“	9	2	S to S
	Iron and Steel (class c)..	7	6	2 tons S to S	6 6	3 8	4 tons S to S 2 tons

The capital of the Manchester Ship Canal Company stands at present at £15,412,000, divided, in order of priority for interest, as follows:

Debenture stock..............	£2,412,000
Manchester Corporation loan...	5,000,000
Preference shares.............	4,000,000
Ordinary shares..............	4,000.000
Total............	£15.412,000*

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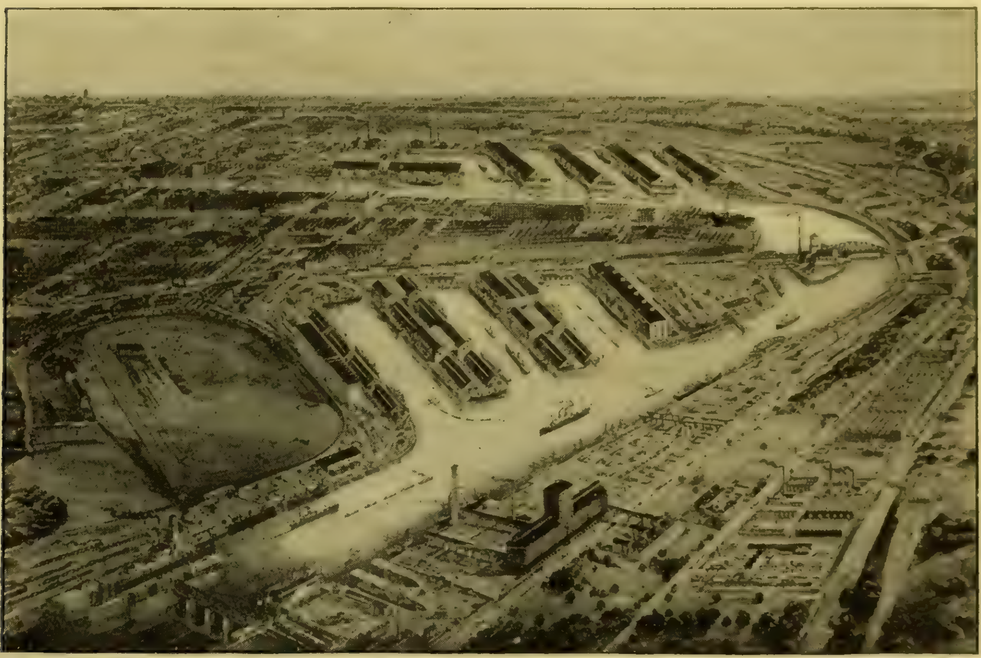
* This sum includes the price paid for the Bridgewater canal and for a vast area of surplus lands, as well as the amount of £1,170,733, paid as interest out of capital.

During the first half of the present year the earnings of the ship canal and the Bridgewater canal were sufficient to provide for all working expenses and maintenance, and to pay interest on the debentures.

There can be no doubt but that, on the closing of the accounts for the present half-year,* the revenue will, in addition to meeting the foregoing claims, leave some margin, which can go toward paying interest on the corporation loan.

This of itself shews that steady progress is being made; but, taken by itself, it furnishes a very inadequate representation of the results of the working of the canal.



GENERAL VIEW OF MANCHESTER DOCKS.

Recently Mr. Reuben Spencer, the head of the great Lancashire firm of John Rylands & Son, and than whom there is no greater authority on the subject, stated publicly that the citizens of Manchester were receiving, in benefit to trade and in increased prosperity, no less than twenty per cent. per annum on the money which the corporation had invested in the canal, or, in other words, that the waterway is *at the present time* worth £1,000,000 annually to Manchester.

On September 7, 1898, Mr. Spencer's words were corroborated in a strikingly practical way, in the city council, by Sir John Harwood, the chairman of the waterworks committee, who announced that a reduction of the rates for water, both in the city and in the

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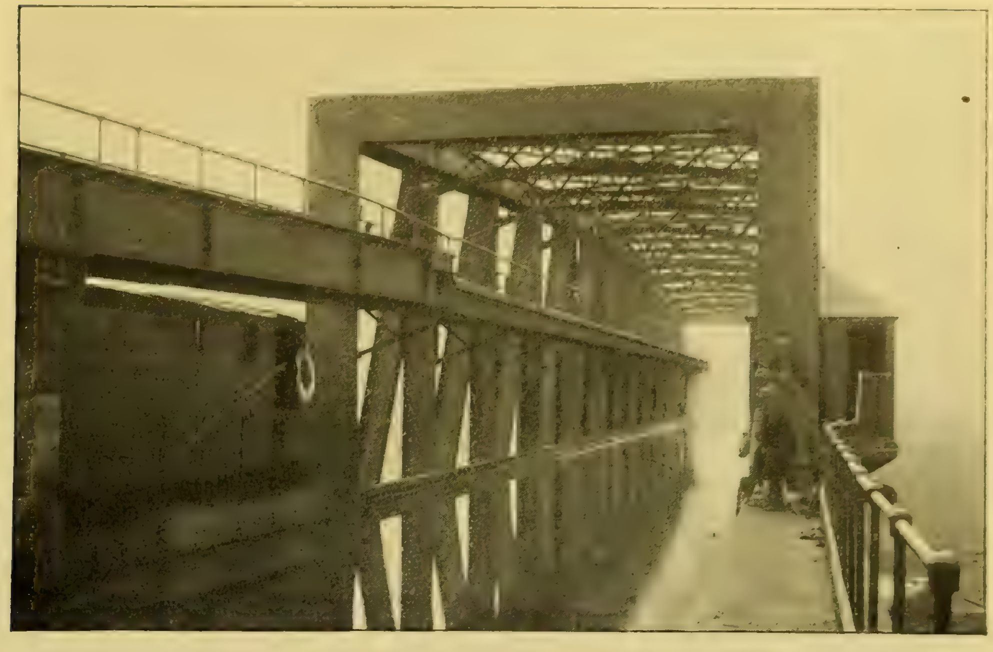
* The second half of 1898.

RUNCORN CANAL AND RAILWAY BRIDGE, MANCHESTER SHIP CANAL.

district beyond its boundaries, would be made at once, which would, at the present time, be equal in value to £35,000 per annum. The significance of this fact can be appreciated only by recalling to remembrance the work which that waterworks committee has accomplished.

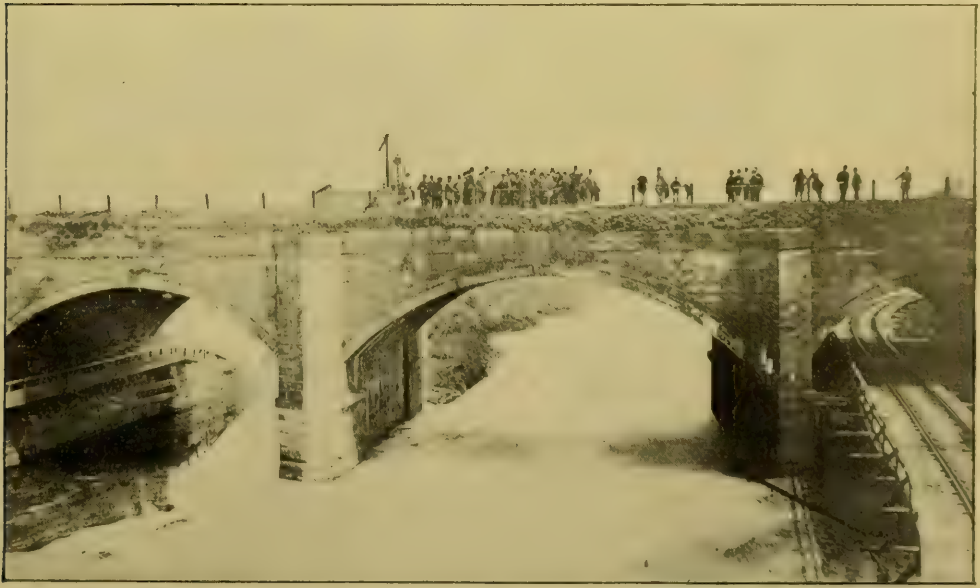
In 1894 the Thirlmere waterworks were opened, as an addition to the previous supply from the Longdendale reservoirs. The total cost of the Thirlmere works was £2,696,899 17*s*. 1*d*. A sinking fund has been established, through which the whole of the indebtedness, *qua*



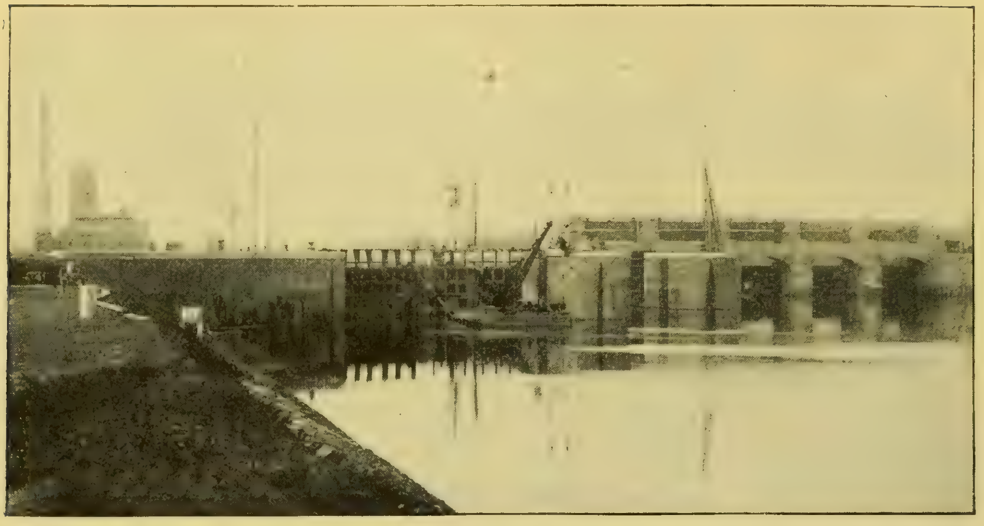
BARTON AQUEDUCT. SWINGING SPAN OVER THE MANCHESTER SHIP CANAL.

the Thirlmere works, will be discharged by January 1, 1960. Notwithstanding this great addition to the annual charges, the waterworks committee were able to recommend a reduction of the charges for water, which would reduce their income by the large sum named.

What is the explanation of the seeming paradox? It is a short and simple one. The demand for water, both for trade purposes and for domestic consumption, has increased so enormously, the revenue



OLD BARTON AQUEDUCT, THE FIRST CANAL AQUEDUCT BRIDGE AND THE PREDECESSOR OF THE FIRST AQUEDUCT DRAWBRIDGE, SHOWN ABOVE.



IRLAM LOCK.

advancing with corresponding rapidity, that the waterworks committee can comfortably meet all their liabilities, and yet lower their rates thus substantially.

No competent person would, for a moment, hesitate, if asked for the reason for this unparalleled progress. It is one of the results of the construction and working of the Manchester ship canal. In the district served by the Manchester waterworks decaying industries have been revived, new industries have been introduced, the movements of trade have been quickened, the population has been increased, and there is no cause to which it all can be attributed except the canal,—no new feature which can be suggested, except the opening of the waterway. Nowhere has the change been more marked than in Manchester

EASTHAM LOCKS, MANCHESTER SHIP CANAL.

itself—in Greater Manchester, which includes the boroughs of Salford and Eccles, and the other districts which encircle and enclose Manchester, and in the city proper.

In 1882, when the canal project, under the guidance of the late Mr. Daniel Adamson, first took shape and began to gather force, Manchester was a city upon which the marks of decrepitude were beginning to make themselves but too apparent. Disused factories, empty warehouses, uninhabited dwellings, were bearing widespread and ominous testimony to the decadence of the great manufacturing centre, and to the inability of the community to maintain the preeminent position which their predecessors had achieved.

In 1898 how great the contrast! Manchester has renewed her youth. On every side and towards every point in the compass she is lengthening her cords and strengthening her stakes; building operations, whether in the way of raising palatial business premises in her centre or of erecting factories and residential property in her constantly extending outskirts, are progressing at a rate which has had no parallel in the long history of the town*; the streets are so thronged with traffic that the problem of dealing with them in such manner as to avoid positive congestion is forcing itself upon the inhabitants, the regulating hand of the law in the clothing of a policeman's glove

POMONA DOCKS, MANCHESTER SHIP CANAL.

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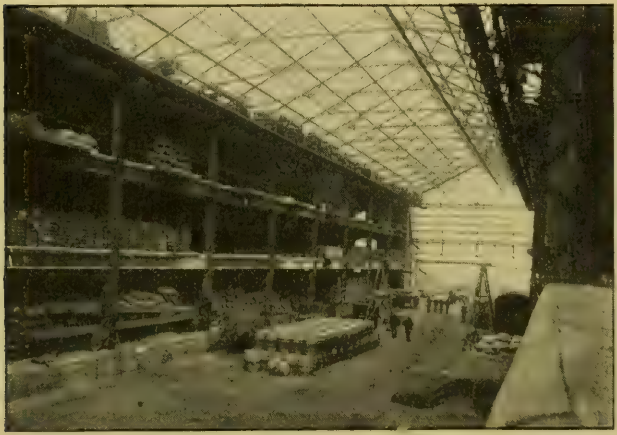
* Towards the close of the municipal year 1897–8 Mr. J. R. Wilson, a member of the Manchester city council and of the improvement committee of that council (the committee to whom all plans for new buildings within the area of the city are submitted) informed a public meeting of ratepayers that, since the opening of the canal, no fewer than *twenty thousand new houses* had been built in or near Manchester, and that plans had been passed for *nine thousand more*. Mr. Wilson further stated that in 1891, before the opening of the canal, there were five thousand unoccupied dwelling houses, which at the present time are all tenanted.

SLUICES ON THE WEAVER.

being required already at almost every crossing of important streets; returns of the railway companies, running into Manchester shew an annual increase so marked that company after company has initiated and carried out, or is in course of carrying out, additions and improvements of a most extensive character, having for their object the increase of their conveying and storing capacity; in a word, threatened decay has been turned into vigorous growth, and adversity into prosperity.

40,000-TON GRAIN ELEVATOR, MANCHESTER DOCKS.

The Manchester men did not "wait till the clouds rolled by"; they made the ship canal, and they are beginning to see the sun shine again, and to reap the fruits of their enterprise, even though as yet but little direct return has been received in the way of interest on the bulk of the capital invested.



TWIN TREBLE-STORY SHEDS, MANCHESTER DOCKS.

It does not demand the assumption of the mantle of the prophet for one to say that the time when interest will be paid on all the capital will come, for the work is only beginning. Many lines of trade are still susceptible of great development; many possible and promising departments of commerce have not yet been touched, and of others only the fringe has been reached; but the progress which is being made is on the lines of least resistance to which reference was made at the beginning of these articles. In other words, it is *with*, and not *against*, nature and natural development, and it furnishes a striking example of the results which may be expected to follow the construction and working of a prudently-conceived maritime canal.

Objection has been made to the increase of competition, already so keen, which must be occasioned by the construction of waterways of the classes to which reference has been made, thus rendering the struggle for existence more acute, and making the doctrine of the survival of the fittest, with the complementary doctrine of the destruction of the least fit, more of an experience in actual life.

The objection cannot be maintained, in view of the better understanding which has been arrived at, by the philosophical scientists of our own time, of the functions of competition in the progress of humanity.

MANCHESTER SHIP CANAL.

COMPARATIVE COST (at per ton of 2240 lbs.) OF CONVEYING MACHINERY, IN PARTS, IN CASES,

To various towns from ex Ship LIVERPOOL and ex Ship MANCHESTER respectively.

MANCHESTER PORT CHARGES.	s.	d.		LIVERPOOL PORT CHARGES.	s.	d.
Ship Canal Toll....	4	0	Included in Through Rate, Column 1.	Dock and Town Dues.............. ..	2	0
				Master Porterage...............about	1	9
				Attendance at Ship and Forwarding	1	0
				Cartage to Railway Station	1	3
Quay Porterage....	2	0				
	6	0			6	0†

† Included in cost via Liverpool, shown below.

TO	1 Ex Ship MANCHESTER		2 Ex Ship LIVERPOOL		3 Saving in favour of MANCHESTER	
	s.	d.	s.	d.	s.	d.
Accrington	13	0 O.R.	18	6 O.R.	5	6
Birmingham	24	0	27	10	3	10
Bradford	17	6	23	6	6	0
Chesterfield	19	6	27	10	8	4
Derby	22	0	28	9	6	9
Halifax	16	6	22	7	6	1
Huddersfield.............	15	6	21	10	6	4
Leeds....................	17	6	22	9	5	3
Leicester	26	6	32	3	5	9
Manchester	6	0	15	2	9	2
Northampton............	31	0	33	10	2	10
Nottingham..............	23	9	30	6	6	9
Sheffield	18	0	26	11	8	11
Stoke-on-Trent	14	7	21	9	7	2
York	24	0	32	8	8	8

MANCHESTER SHIP CANAL.

COMPARATIVE COST (at per ton of 2240 lbs.) OF CONVEYING
IRON AND STEEL, 2-TON LOTS,
unless otherwise stated,
To various towns from ex Ship LIVERPOOL and ex Ship MANCHESTER respectively.

MANCHESTER PORT CHARGES.	s.	d.	
Ship Canal Toll....	3	0	Included in Through Rate, Column 1.
Quay Porterage.....	1	0	
	4	0	

LIVERPOOL PORT CHARGES.		s.	d.
Dock and Town Dues.......	about	1	0
Master Porterage	“	1	1
Attendance and Forwarding.......		0	3
Cartage to Railway Station........		1	3
		3	7†

† Included in cost via Liverpool, shown below.

TO	1 Ex Ship MANCHESTER			2 Ex Ship LIVERPOOL			3 Saving in favour of MANCHESTER	
	s.	d.		s.	d.		s.	d.
Accrington	8	0		11	6		3	6
Birmingham	13	0	delivered	13	7	delivered	0	7
“	11	4	4 tons	11	11	4 tons	0	7
“	10	8	10 tons	10	8	10 tons		
Bradford	10	0		12	9		2	9
“	9	6	4 tons	12	4	4 tons	2	10
“	8	9	10 tons	12	4		3	7
Derby	12	0		16	1		4	1
“	10	6	4 tons	12	9	4 tons	2	3
Halifax	9	6		11	11		2	5
“	8	9	4 tons	11	11		3	2
Leeds..................	10	0		12	9		2	9
“	9	6	4 tons	12	4	4 tons	2	10
“	8	9	10 tons	12	4		3	7
Leicester	13	10	4 tons	17	7	2 tons	3	9
Manchester	4	0		9	5		5	5
Northampton............	16	0		19	9		3	9
Nottingham.............	12	6		16	1		3	7
“	12	0	4 tons	15	3	4 tons	3	3

In that progress competition is as the breath of life. Without it not only can nothing more be achieved, but that which has been achieved cannot be maintained. Without it degeneracy, which will affect not only the material prosperity and the comforts of the people, but also the moral fibre of the race, will take the place of development. Without competition, mankind will go backward, and that in an ethical as well as a material sense; for it is not only *a* means by which human exertions are quickened and human energies braced, but it is *the* means through which those who are most competent to guide, to direct, and to help their fellows find their true place in the forefront of the battle; and there are to-day few, amongst those whose judgment is of value, who will deny that this tends to raise the tone and the standard of the whole race, and is therefore for the benefit of all.

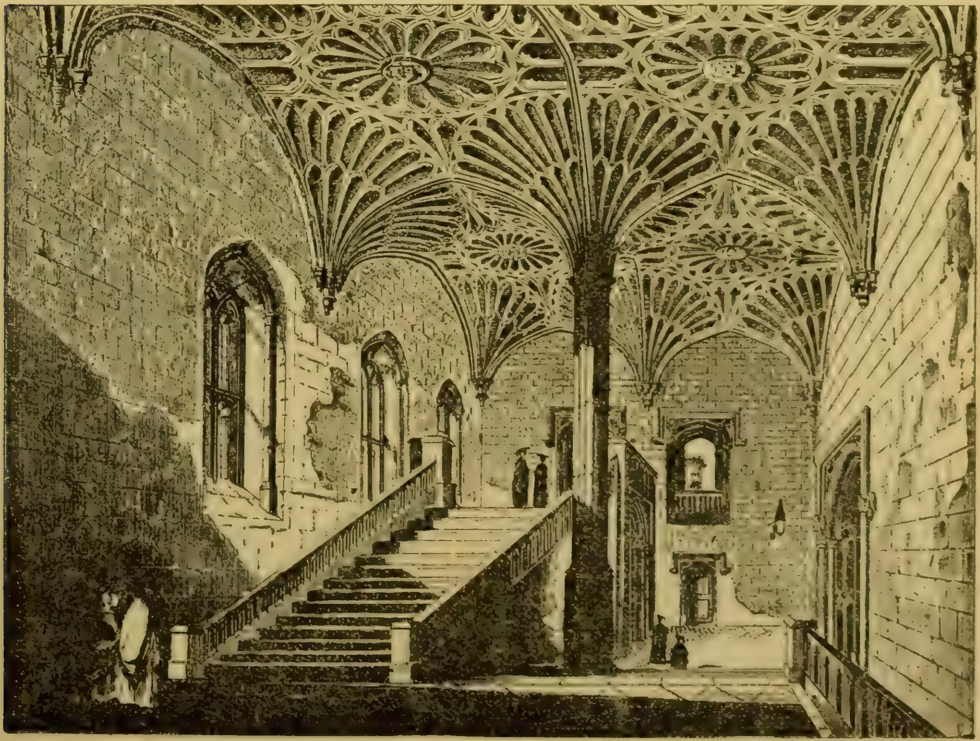
THE BUILDINGS OF OXFORD FROM AN ENGINEER'S POINT OF VIEW.

By J. W. Parry.

FOLLOWING our review of some of England's most famous structures from the new viewpoint of an engineering examination, we considered briefly, in the preceding number of THE ENGINEERING MAGAZINE, the principal features to be observed in passing down the High and through King street, until we arrived at S. Aldate's.

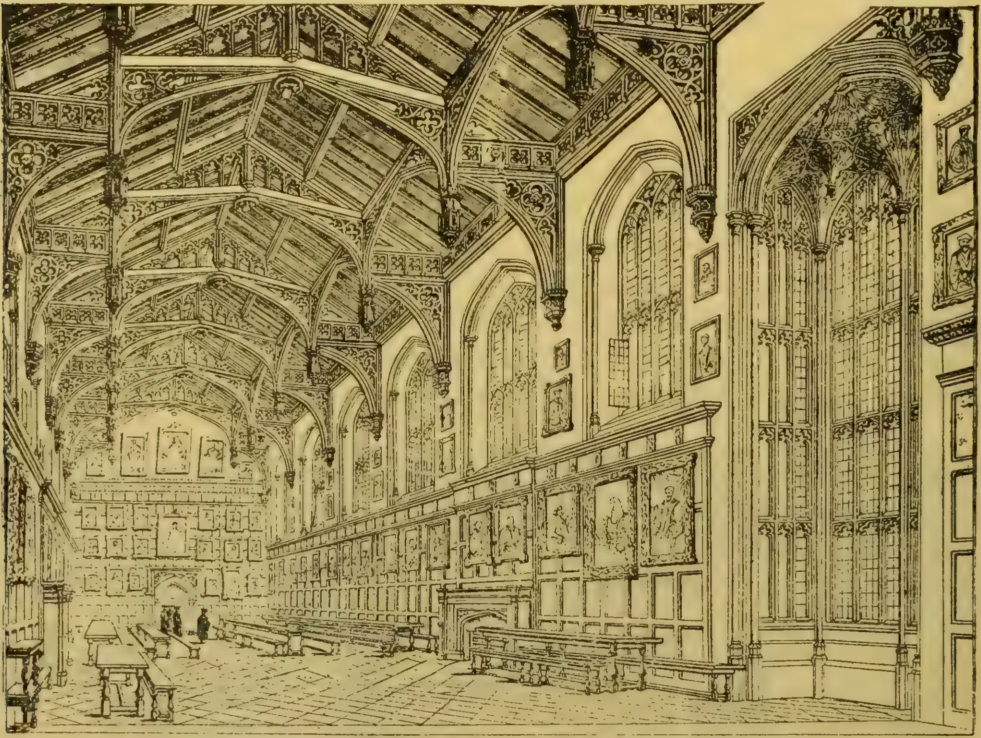
We shall enter Christ Church from S. Aldate's under the Old Tom gateway, though, to have followed the sequence of this narrative, we should enter through the Canterbury gate. Much might be written about this magnificent college, but only a few important features can be brought forward here.

The great quad measures 264 by 261 feet, and is exceeded only by that of Trinity College, Cambridge. The southeast and west portions were finished by Wolsey, who intended to place a handsome church on the north, but fell into disgrace before the design could be com-



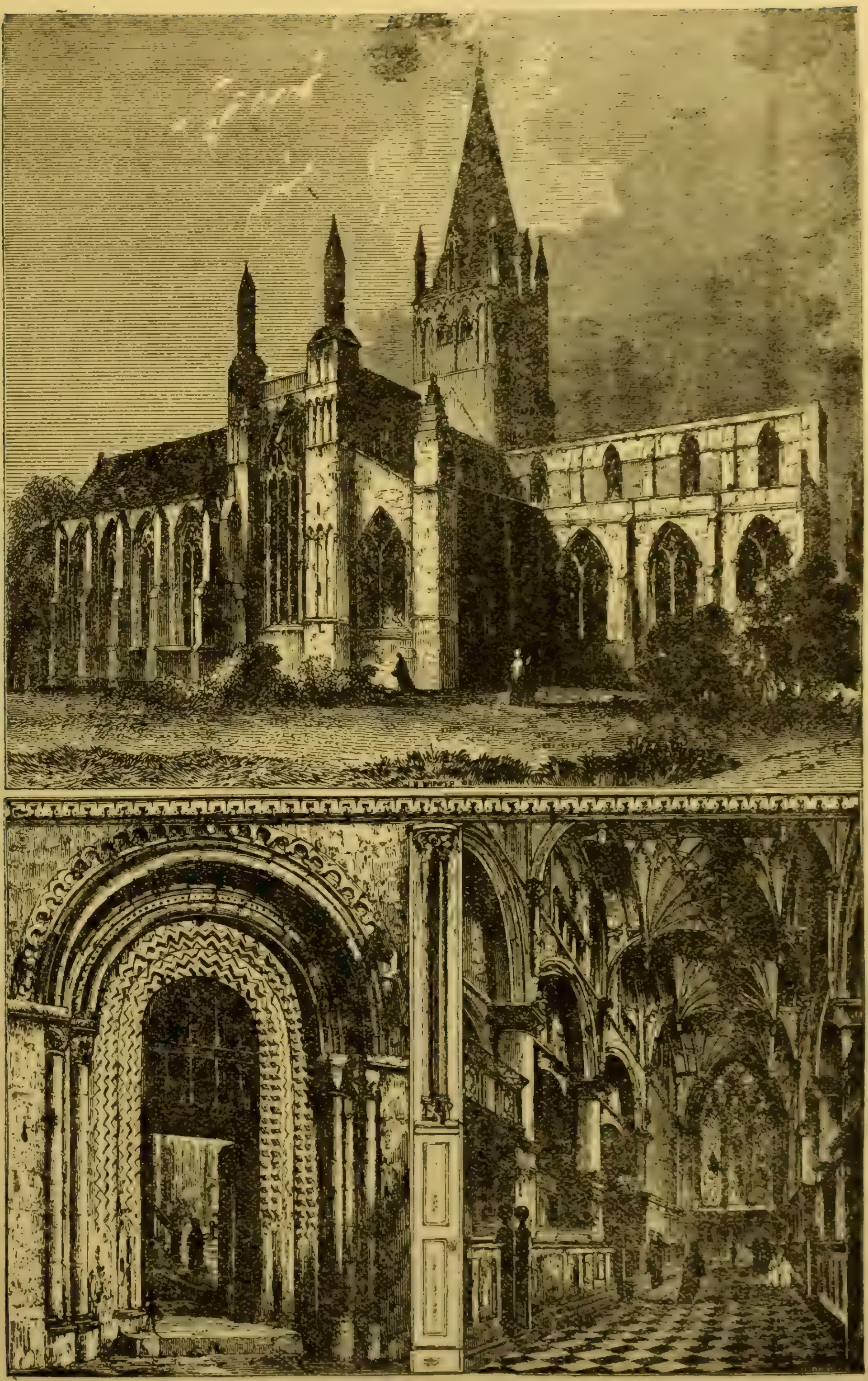
ENTRANCE TO DINING HALL, CHRIST CHURCH COLLEGE.

pleted. It is stated that in 1528–1529 Wolsey spent £7,835 on his college, which he expected to be the most magnificent in the world. There was to have been a handsome cloister around this quad, as the projecting piers and commencement of ribs testify. The kitchen still retains its original size, shape, and interior arrangements of roof and fireplaces, being one of the finest specimens in England. The entrance to the hall is about 40 feet square, and the vaulted stone roof, of exquisite fanwork supported by a single slender pillar, justly claims admiration from every engineer or architect. The magnificent hall, 115 feet by 40 feet, and 50 feet high, shows Wolsey's vast intentions, the carved roof being profusely decorated with armorial bearings.



INTERIOR OF THE HALL, CHRIST CHURCH COLLEGE.

In the cathedral we see the three-fold division of pier arches, triforium, and celestory; at one time it was intended to add another stage, but, as cracks and fissures began to appear, the square tower was made into a spire having a pyramidal coping of stone. While the majority of the columns are cylindrical, four are octagonal, and their treatment is peculiar. The main pillars of the building are, as it were, halved when they reach ten feet in height; one-half is continued upwards to its half capital, from which spring the ribs of the higher vaulting, and the other half is stopped by a half capital, from which start the ribs of the aisle-vaulting. Similar treatment of shafts is to be seen at Hyde abbey and Winchester. The choir is specially



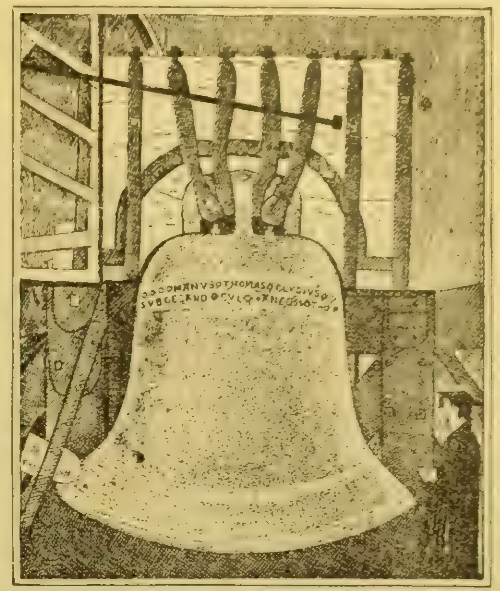
OXFORD CATHEDRAL.

worthy of study, on account of the double arches, a lower arch springing from the corbels attached to the piers and rich pendants. There is similar "Stella" vaulting at Tewkesbury; St. George's, Windsor; Kings College, Cambridge; and Henry VII's Chapel, Westminster.

In the Lady Chapel there are the remains of three narrow entrances, which, Mr. Park Harrison thinks, were three apses, while Mr. James Parker says that they were barrow-holes; they certainly look more like the latter. In the Latin Chapel there are arches of the twelfth, thirteenth, and fourteenth centuries contiguous to one another; we see that the mouldings differ. In 1856 a small crypt was discovered —of Norman times, and unique of its kind; it is conjectured that it was used as a secret chamber to contain the S. Frideswide or University chest. On going into the roof of the choir, the writer was surprised to find an air space, and then a second roof on trusses covered with lead. Examination of several old roofs indicates that this precaution was generally adopted in England wherever groined vaulting was used. The writer has constructed cylindrical vaulting, and domes as well, on the Indian State railways, but he certainly did not place a second roof above either of these coverings, although the rainfall in India is far heavier than that of England. The Chapter House is said to be an admirable instance of early English architecture, the door being Norman. The passage between the cathedral and the Chapter House is termed a "slype."

It is necessary to notice the handsome Broad walk, with its avenue of trees leading to the river, which was raised above flood-level with the stone chippings left from the buildings, and was called White walk, then Wide walk, and finally Broad walk.

Over the entrance to the hall is the campanili containing the belfry. The "merrie Christ bells" were removed from the old tower of the cathedral to the campanili, though the walls of the former had been strengthened by bands of wrought iron 8 inches deep and 1 inch thick all round the tower, as well as tie rods through the tower. It has been found that the walls of the campanili are made of excellent masonry, being probably intended to hold the bells in Wolsey's original design. There are twelve bells, ranging from 400 to 3,000 pounds, and no cracks have been visible, though the bells have been ringing for thirty-five years (1863). Here it may be added that the Tom Tower contains a bell 7.8 tons in weight,—one of the largest in England,—which tolls 101 times at 9 P. M. The timber framing is one of Wren's best designs. No one would venture, however, to ring or turn such a mass; the heavy clapper is merely pulled against the side of the bell, as shown in the quaint illustration. The framing consists of four raking pieces 15 inches by 12



WREN'S METHOD OF SUPPORTING 7½ TONS.

inches, firmly bedded into two large timber beams which rest on the walls, and connected at the top by two horizontal beams; in addition, there is cross bracing at different heights. Across the two upper horizontal beams there is a mass of timber, 7 ft. by 3 ft. 9 inches deep by 1 ft. wide, from which the bell is slung. What excites our admiration is the lifting of nearly 8 tons to a height of 275 feet with pulley blocks and winches alone—for it must be remembered that hydraulic machinery, steam cranes, screw jacks, steel joists, and deep iron girders were unknown in Wren's time. The illustration only shows the large timber mass from which the bell is slung; this mass has several through bolts and seven iron straps.

Pembroke College.—This is chiefly famous for being Dr. Samuel Johnson's college, his rooms being shown above the entrance gateway. The hall has a hammer beam roof with a louvre, which often leaks after a storm. The chapel is ornamented with Ionic pilasters between the windows. There is certainly an unusual amount of dim religious light in the chapel, due partly to the dark-colored glass, and partly to the thick framework of iron behind the glass. In the Senior Commons room is a drawing showing that the previous chapel was attached to S. Aldate's Church, with the library above; since then the old hall has been converted into the present library.

S. Martin's Church Carfax.—The meaning of Carfax is quatre voies, or quadvivium, or the meeting of four ways. The foundation of the church is "beyond all record." The advowson was given by Canute to the Benedictine Monks in 1032. A small portion of the original structure may possibly exist, but the tower was pulled down in Edward VI's time, as the people annoyed the scholars with arrows and stones, giving rise to the gown and town riots. The above is stated by Messrs. Ingram and Parker. On the other hand, Mr. Hurst insists that the document appealed to has reference, not to a tower, but to an aisle. The foundations of the tower are more than twelve feet below Queen street. On examining the stratification it becomes apparent that the street has been gradually raised this amount; during high floods even this part of the city was liable to be submerged. In 1894 the church was pulled down to widen Queen and Cornmarket streets.

Previous to 1787 there was a conduit or fountain for supplying the colleges and halls with water, but, as it blocked the way, it was presented by the authorities to Sir Vernon Harcourt, who has reconstructed it at Nuneham.

Lincoln College.—On entering the northern quad one cannot help noticing the belfry over the present library, which formerly was the chapel. The roof of the hall was reopened and restored in 1889; previously it had been covered with lath and plaster. Beyond is the old kitchen with thick walls, said to be of the thirteenth century; still further on is a small door leading into Brasenose.

Passing into the chapel one can at once smell the cedar in the wainscotting, screen, and Wycliffe's pulpit. The prophets and apostles on the stalls are finely carved, and the tracery of the window is a good example of the time. The east window has six upper and six lower compartments, showing the types and anti-types of Christianity. The chapel is 62 feet by 26 feet, by 26 feet high; the ceiling is panelled, indicating a trussed rafter roof.

Exeter College.—Few of the colleges have undergone so many building operations and architectural changes as has this, the western gateway alone having been built four times—in 1404, 1600, 1700, and 1834. The original chapel cost £1,400; the present one, built in 1858 by Sir Gilbert Scott, cost £17,000. It is one of the finest in Oxford, being modelled after the Sainte Chapelle in Paris. It is 100 feet high, and has an apse with a groined vault and well-carved ornaments. The exterior buttresses are unnecessarily thick, and scarcely in keeping with the rest of the design.

The hall has a high-pitched roof of handsome framework, with a curious kind of reticulated ceiling, lattice girders with trellis work on the top being an unusual method of construction. In 1832 the college buildings were extended 220 feet into Broad street. In the gardens there are two famous trees, one being Dr. Kennicott's fig tree on the wall and the other Bishop Heber's tree at the end of the walk.

Jesus College.—This building is situated on the opposite side of the Turl, and is chiefly intended for Welsh students. From a drawing in the hall it is apparent that there is a hammer beam roof, which, however, is closed in to make four rooms for the principal's servants. The screen is carved in detail, showing the Welsh dragon and other symbols, the bay window forming a bold projection into the inner quad. The chapel has a panelled roof, carefully restored; when the chancel arch was enlarged, the handsome variegated marble reredos and floor were put in.

S. MARTIN'S CHURCH, DEMOLISHED TO WIDEN QUEEN ST.

S. John's College.—A careful observer may still discover, on the north and south sides of the tower, the ledges which mark the apex and inclination of the former roof, which was not so flat and had no dormer windows. The old sculptured cornice, too, remains on the northern gable. The hall was the refectory of the monks. There is a louvre, which possibly had a bell in it. The kitchen and out offices have some fine old chimneys. The Dons Commons room has wain-

THE HALL OF EXETER COLLEGE.

INTERIOR OF THE HALL, EXETER COLLEGE.

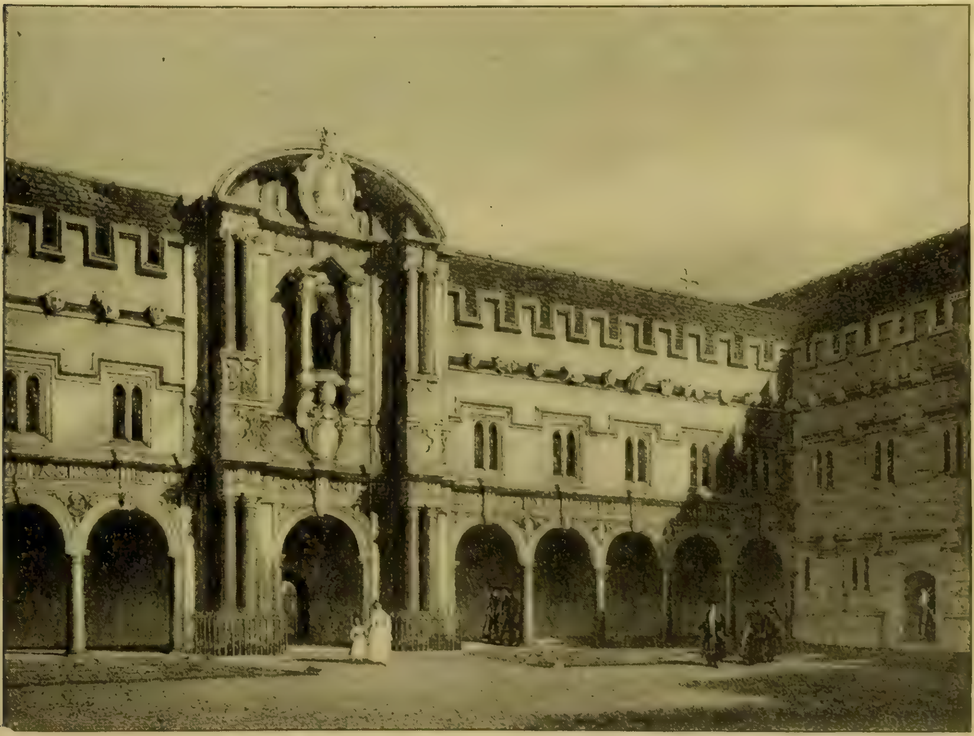
scot covering the whole of the walls, and the ceiling is decorated with shell work in stucco (1676).

The inner quad is occupied by the library, to which King Charles contributed 200 tons of timber from the woods of Shotover and Stow, the designer being Inigo Jones. The colonnade of sixteen pillars consists of Bletchingdon marble in a florid style. The beautiful garden of five acres, having Dutch elms (stunted pollards), boxwood, and other trees, is worthy of inspection. The imitation terrace and

S. MICHAEL'S CHURCH, WITH NORMAN TOWER CRACKED BY RINGING OF BELLS.

wilderness mentioned by Ingram seem not to exist at the present time.

S. Mary Magdalen.—Formerly the north aisle was used as a chapel for Balliol students, subsequently being rebuilt and called



INNER QUADRANGLE OF S. JOHN'S COLLEGE.

Martyrs' aisle. The peculiarity of this church is that its aisles run at right angles to its length; there are four of them, terminating in one line at the east end.

S. Michael's Church.—The most important feature of this church is the tower, which is generally called Saxon, but is really Norman (circa 1080); it is, however, scarcely worthy of the grand Norman builders. The tower formed a protection to the northern end of the city, an arch being turned between this abutment and the present Leopold arms; above the arch was the Bocardo prison. The

INTERIOR OF OXFORD CATHEDRAL.

old city walls were run just to this point, for slight remains of a bastion can still be seen in the cellars of the Leopold arms and the house north of it.

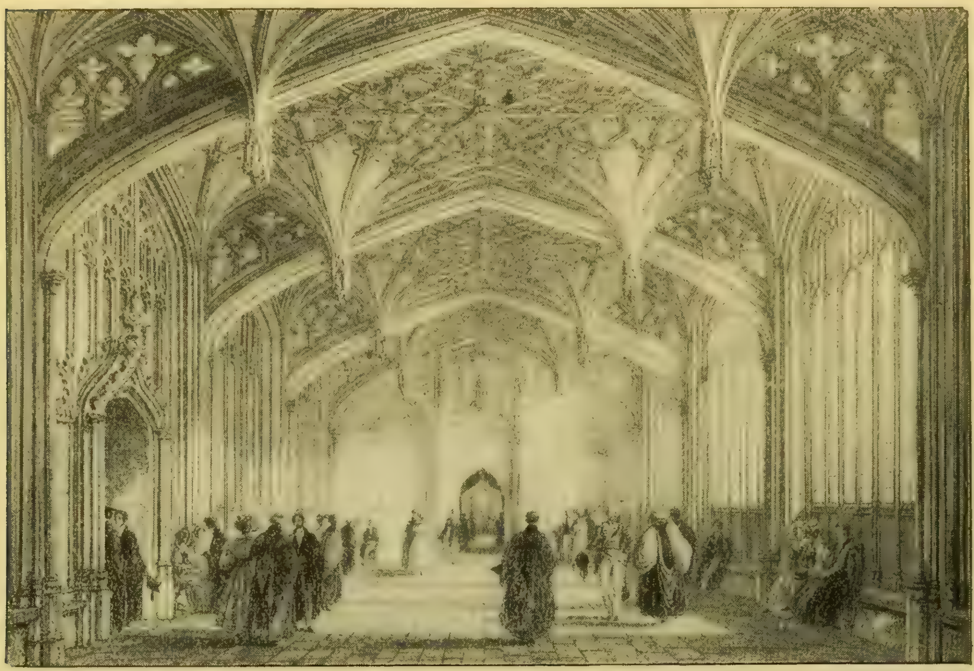
This is one of the churches in which the ringing of the bells cracked the tower, for the bells were hung to ring in the same direction. After patching up the tower, the bells were taken down and deposited in the churchyard; lately, however, they have been returned, and are being re-hung for chiming purposes only.

Balliol College.—The chapel is the fourth since the foundation; it was built in 1856, in different kinds of masonry, abutting Trinity College grounds, the eastern window being of Derbyshire alabaster.

FRONT OF BALLIOL COLLEGE.

The old hall is now a lecture-room, while the new hall is the largest in Oxford, excepting Christ Church hall. The extension on the premises into S. Giles was made in 1869 by Mr. Waterhouse.

Trinity College.—There are two handsome pairs of iron gates, one in Broad street and the other opposite Wadham College. The chapel is said to be one of the best specimens of Corinthian architecture in England; the gateway and tower are of the Ionic order. The carving of the screen and altar piece is chiefly admired, reminding one of the carvings in Burmese pagodas. It is a pity that the north and south wainscot is not also carved or decorated, in harmony with the screen. The ceiling has a large painting by Peter Berchet, unusual in Oxford chapels. The hall is devoid of decorations. The roof was reconstructed at the beginning of this century, and another



THE DIVINITY SCHOOL.

set of rooms added for undergraduates. As a rule, there are no rooms above the halls. Over the end of the hall is a curious old belfry.

Trinity, however, is chiefly noted for its pretty garden of four acres, with its large yews, and for the avenue of lime trees.

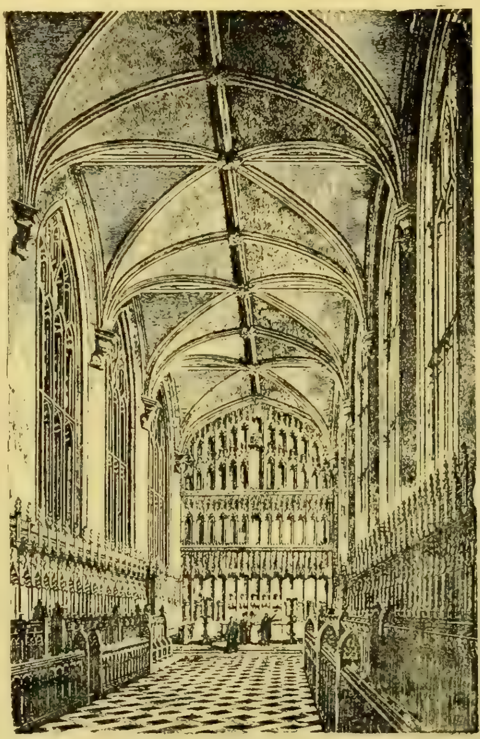
The Old Schools.—It is interesting to note that these were erected to accommodate ten schools,—five below and five above. In 1624 the latter were utilised for the Bodleian library, while in 1881 the former also were taken over for the same purpose, new schools being erected in High street. The entrance gateway is a noble one, twelve feet span ; on the inside will be noticed the five classic orders, —namely, Tuscan, Doric, Ionic, Corinthian, and Composite, the plinthus of the columns being enriched with Arabesque ornaments in Elizabethan taste. Passing through the quad, we enter a lofty vaulted passage termed the Proscholium, which was used during the rebellion as a pig market ; through it we reach the old Divinity School.

This is one of the gems of Oxford. The exquisite fan vaulting with figures in the niches has seldom been equalled anywhere. It is known that at one time the windows were filled with richly-stained glass and the roof colored ; the beauty must thus have been enhanced to the ordinary beholder, but not to the constructive eye of an engineer or architect. The pendants are beautifully carved, the bosses being ornamented with emblems. shields, words, or initials of benefactors, or with sacred monograms, some of these being cut in remarkably high relief. Anthony Wood has made a collection of ninety-two of these. By passing through a door at the opposite end of the school we come to the Convocation House, where the statutes for the University are framed and the vice-chancellor holds his court.

Wadham College.—As the site is absolutely barren in Agas's map of 1588, there is no probability that the original stonework of the chapel for the Augustine friars was copied when the college was founded in 1610, as stated by Messrs. Ingram, Parker, and other authorities. The probable truth, first pointed out by Prof. Freeman, is this,—that the masons employed, being Somerset men, continued to build in a kind of Gothic which was prevalent in that county and was one hundred years behind the Gothic in use in any other part ot England. The lofty arches and pillars of the ante-chapel are worthy of admiration; the east window is 22 feet span, divided into five compartments. The contract document for this window, £100, in 1621, and detailed accounts of all expenditure since the foundation, have been preserved. In the ante-chapel is the mechanism of the old clock, said to have been designed by Sir Christopher Wren and used till 1870.

The hall is 82 feet by 35 feet, by 37 feet high. The hammer beam roof with its louvre, and the oak screen, should be noticed.

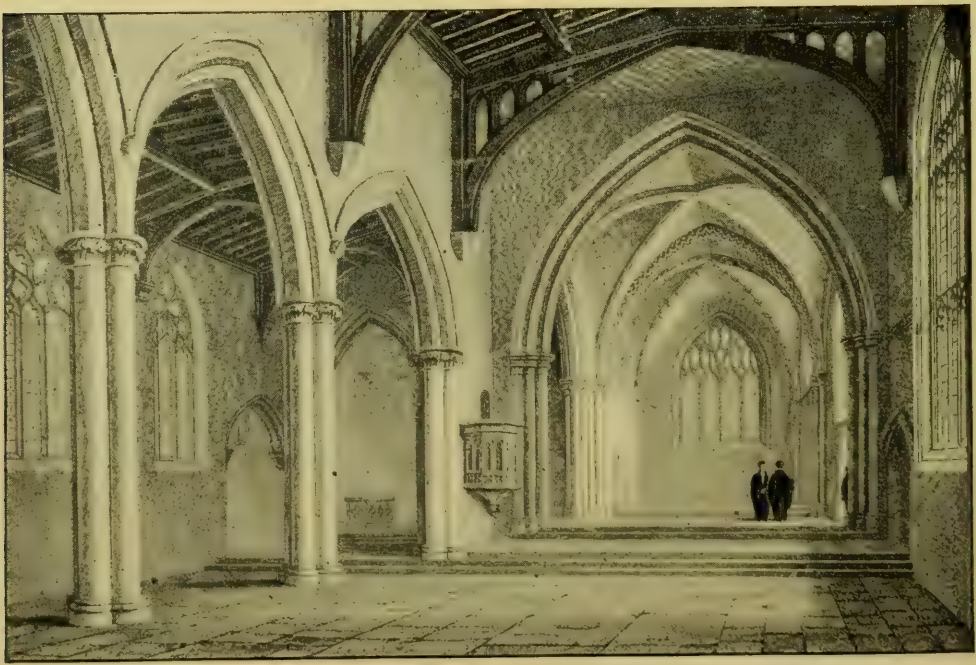
NEW COLLEGE CHAPEL AND TOWER.
The foreground is now occupied by the new buildings.



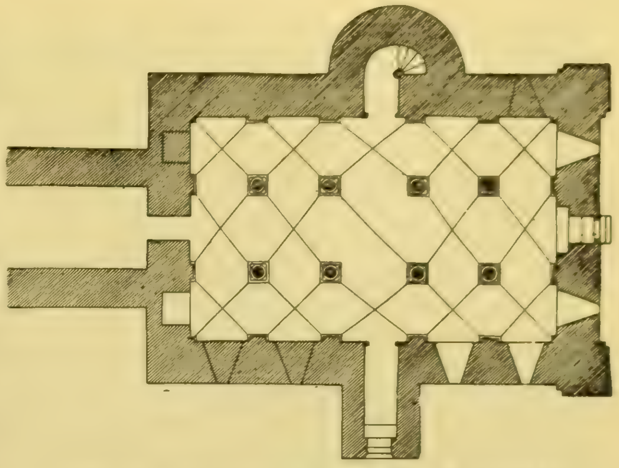
NEW COLLEGE CHAPEL.

Hertford College.—The modicum of accommodation in the pigmy chapel here shows how easily the churchmanship of the last century could be satisfied. In modern times it has been rumoured—though tell it not to the principal—that some of the stalwart members of the University football team get cramps in their legs during devotions, and, becoming irritable, wish to "hack it through."

New College.—The legal title given by the founder is "S. Mary's College of Winchester at Oxford." Ingram tells us that, "after a lapse of more than four centuries, the buildings remain substantially entire to this day. The lofty hall, the magnificent chapel, the solemn cloisters, the groined gateways, and even the original doors and windows in many cases, remain undisturbed." Those words were penned more than sixty years ago, and are still true.

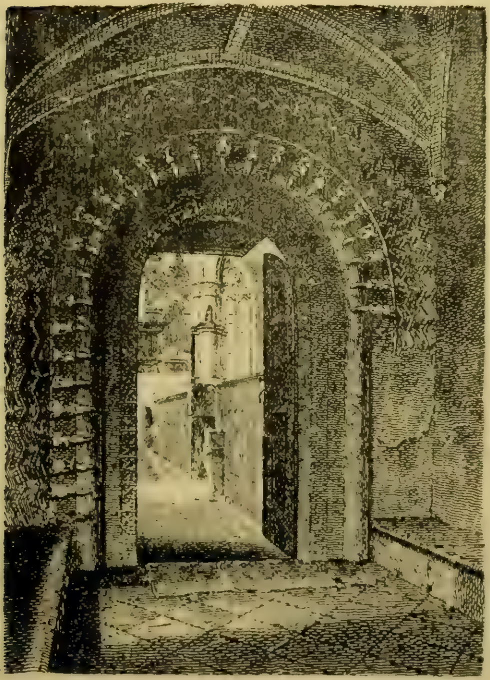


INTERIOR OF S. PETER'S CHURCH, SHOWING CHAIN ORNAMENT.



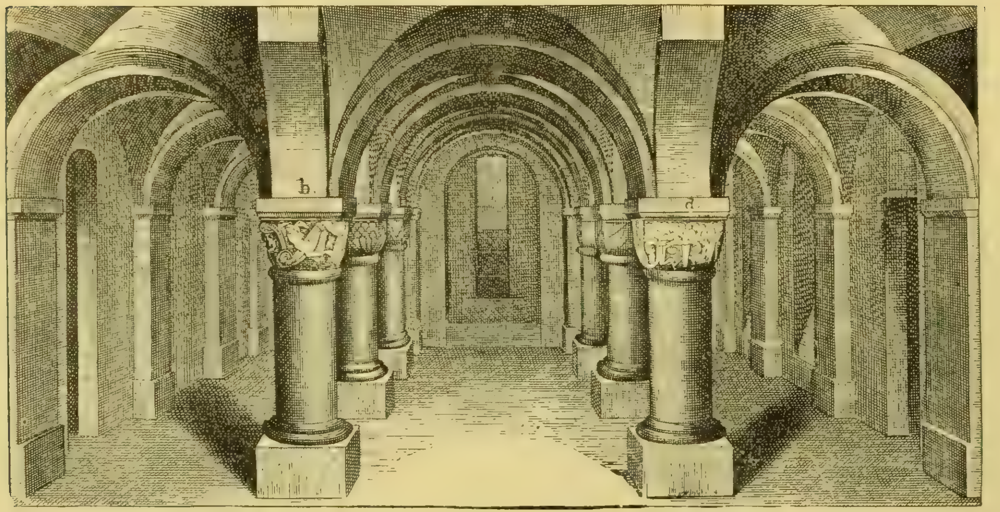
PLAN OF CHURCH OF S. PETER-IN-THE-EAST.

In the chapel the reredos is similar to the one in All Souls, already mentioned, though of course long anterior to it. In fact, All Souls Chapel was modelled on the one at New College. The upper small lights of the chapel and all the windows of the antechapel — except the western ones — contain original glass, and so curious are they that Messrs. Parker & Co. have published engravings of them. The tower stands on the site of one of the bastions of the old city wall, and has a belfry with ten medium-sized bells. The ringing of the bells has not affected this tower, the walls being six feet thick and of good masonry. The muniment tower, like the one at Merton, is an excellent example of a fireproof structure, five centuries old, with groined ceilings and tiled floors. New buildings for 36 students were added in 1878 by Gilbert Scott; further additions were made by Champneys; and it is proposed to further increase the accommodation when the leases of the adjoining houses fall in. These new buildings have been erected outside the old city walls, for we see in the Oxford almanac for 1844 that the site is barren.



SOUTH DOOR OF S. PETER'S CHURCH.

S. Peter-in-the-East Church. —Of all the buildings in Oxford, this church receives most adoration from antiquarians. The chief feature is the crypt vaulting of semi-circular arches, said to be of the ninth century. Above this we have the ribs of the choir, having a chain ornament which is of rare occurrence. The unique point of the church is that at the western end of the crypt there are the remains of three openings; one of these, the central one, intended for a shrine, is open, while the other



THE CRYPT OF S. PETER-IN-THE-EAST CHURCH.

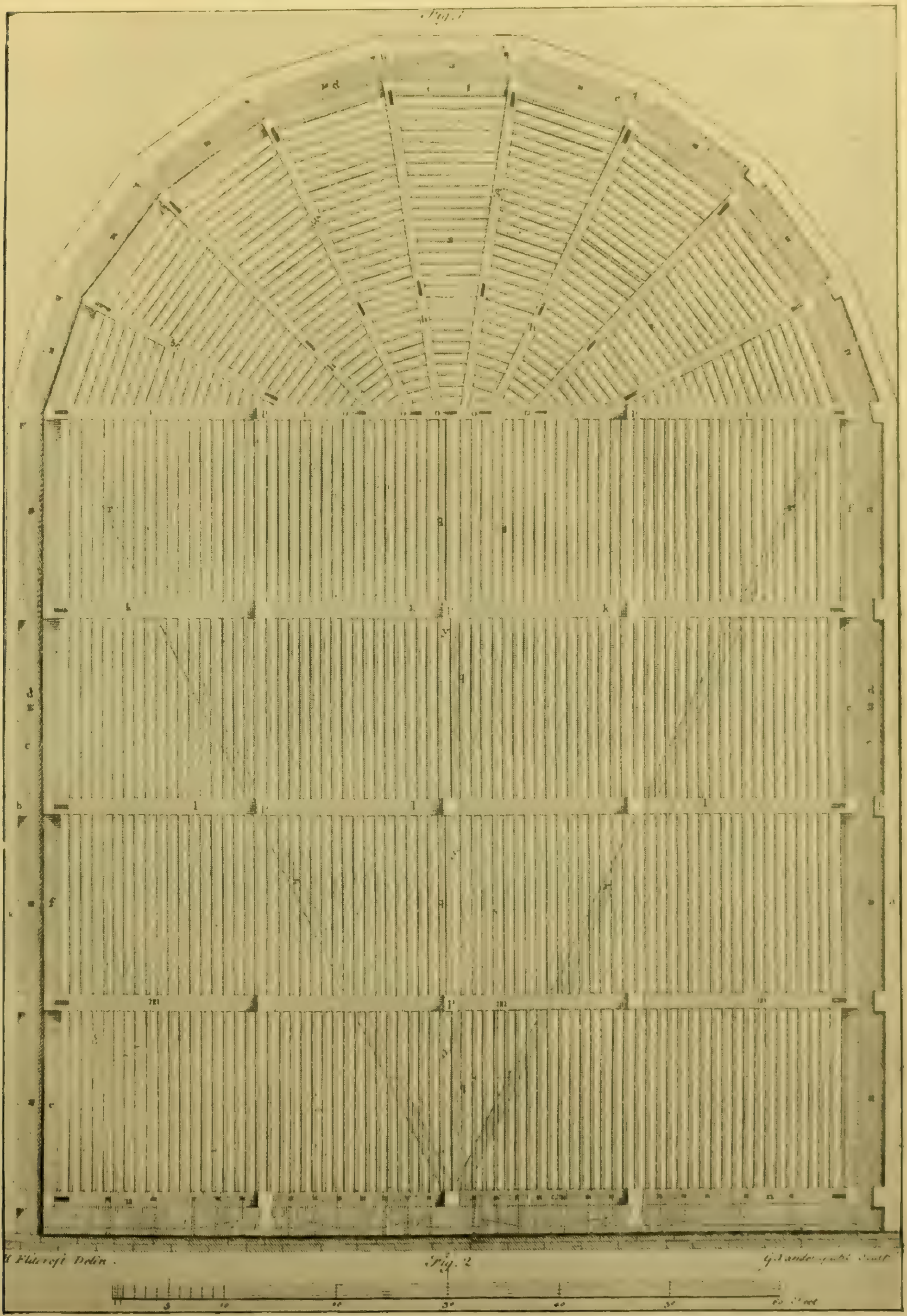
two are blocked up. In 1864 both were opened, and steps were discovered leading up into the nave. Of the present chamber, or chambers, over the east part of the chancel, little but the windows remain. This church furnishes the best example in Oxford of a room over the porch containing church warden's accounts, perhaps the oldest of any in England (1444).

Worcester College.—On entering the quad, one finds an open arcade or piazza: on the south side of the quad will be seen some of the old lodging-houses of the Benedictine Monks.

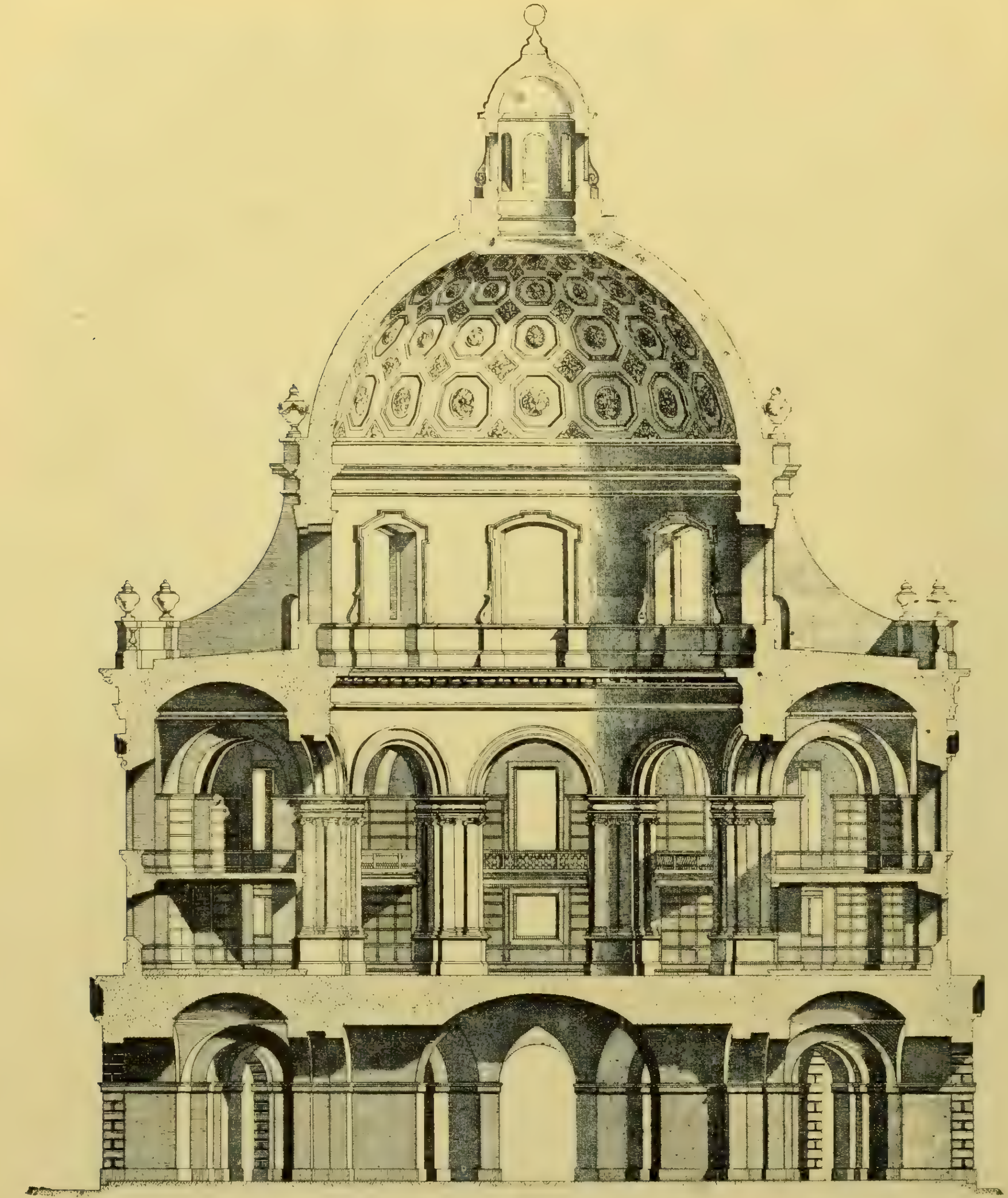
The chapel has a small dome in the centre; the intersection of the arches, and the ceiling paintings, bring to mind the Sistine chapel at Rome. The interior is very dark, partially because of creepers covering up the windows and partially because of the proximity of a building on the north side. The hall has rich panelling inlaid with the coats of arms of benefactors.

The Sheldonian Theatre.—This is an enormous space of 80 feet by 70 feet, covered in by timbers. In the "Parentalia," published by Wren's grandson, we get details of the roof, which have been specially engraved and photographed for THE ENGINEERING MAGAZINE. *a a*, walls of building; *b b*, pilasters of the rails and ballister; *c c*, lead; *d d*, pipes for water; *e e* and *f f*, wall plates and lintels; *g g*, girders of the semicircle, each supported by a king piece or crown post cut off at *h h*, and screwed into binding beam *i i*; *k k*, *l l*, *m m*, also binding beams; *o o*, prick posts let into *i i*, which also support *p p*; *q q* show the purlins between the binding beams, not set against one another because of the dragon beams or braces, *r r*; *s s*, joists; *t t*, principal rafters; *u u*, crown or king posts; *w w*, prick posts; *x x*, braces, or puncheons; *y y*, cross posts.

The painting of the ceiling is worthy of examination, recalling the method of covering the ancient theatres with open roofs; in this instance the corded moulding merely gives the impression of supporting the wide expanse of painted canvas. It is probable that the roof was intended for storing away light papers or packages, for it was con-



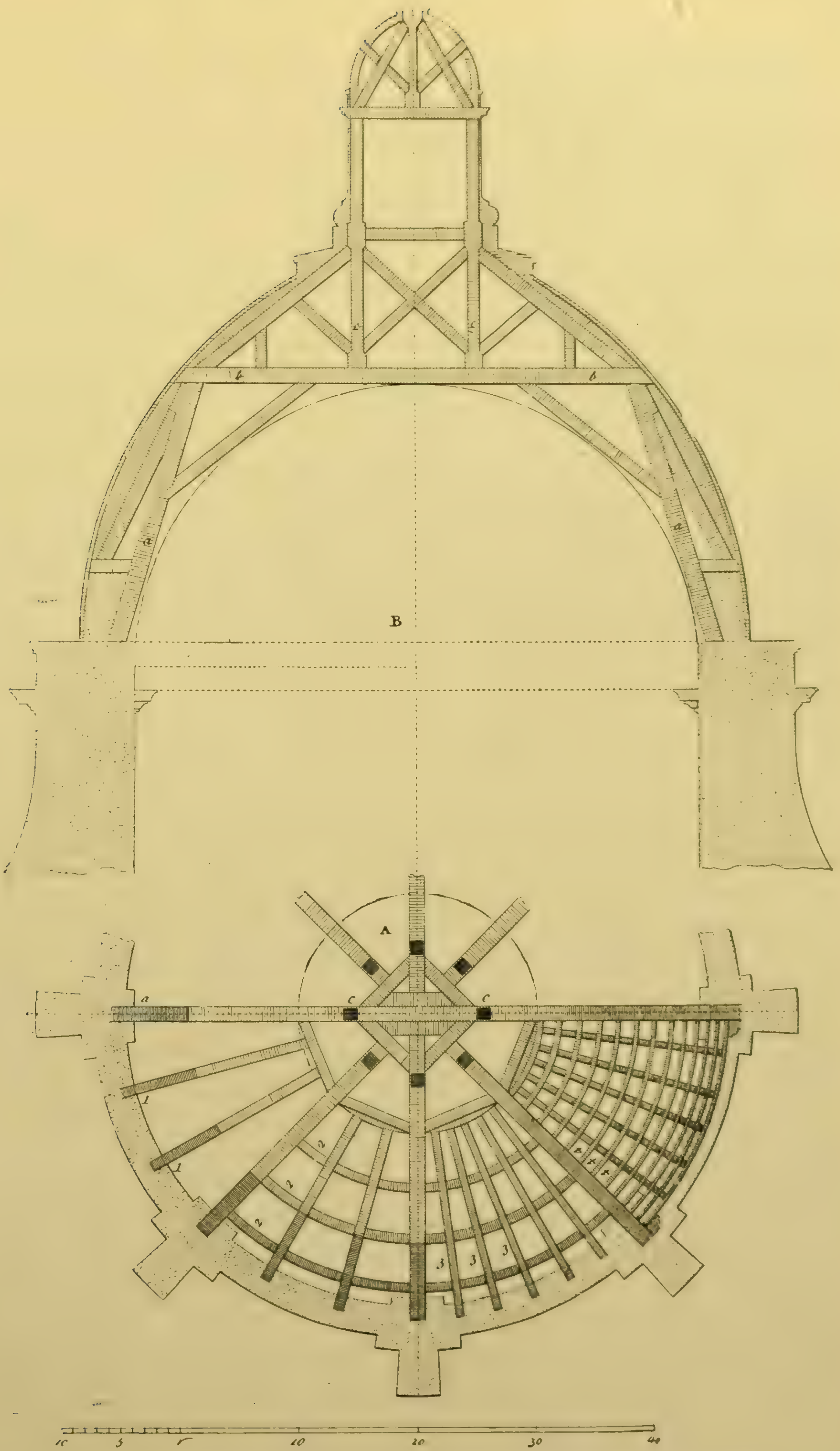
PLAN OF THE ROOF, SHELDONIAN THEATRE.



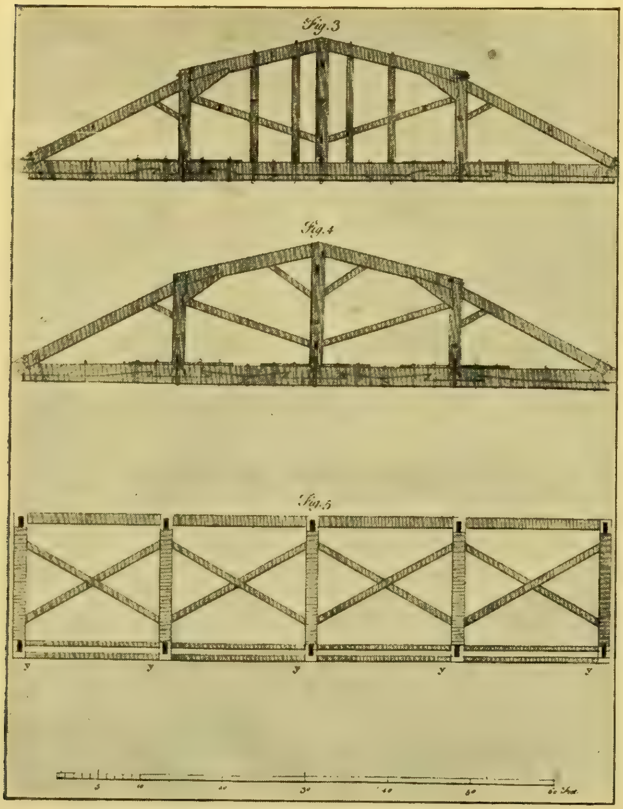
SECTION OF RADCLIFFE LIBRARY.

nected with the early printing-office of the University situated in the Clarendon building close by. The timbers, however, began to sag, and the weight had to be transferred to the basement.

The Radcliffe Library.—This is an imposing building, of which the architect, James Gibbs, has given us an account. The following is epitomised from his "Bibliotheca Radcliviana." Dr. John Radcliffe left £40,000 for building this library; it was commenced in 1737, and finished twelve years later. A vertical section and the



RADCLIFFE LIBRARY. PLAN AND SECTION OF WOODEN FRAMING.



ROOF TRUSSES, SHELDONIAN THEATRE.

framing of the centering are given as illustrations. The base is a polygon of sixteen sides, 88½ feet in diameter; above this is a circular structure 48 feet in diameter, consisting of eight large blocks of masonry 6 feet by 5 feet, which carry the cupola, as also the arches over the library. The ceiling is embellished with fretwork and lighted by seven large windows and a lantern; the dome or cupola is 84 feet from the pavement. Attention is called to the railings of the staircase, which are of embossed copper.

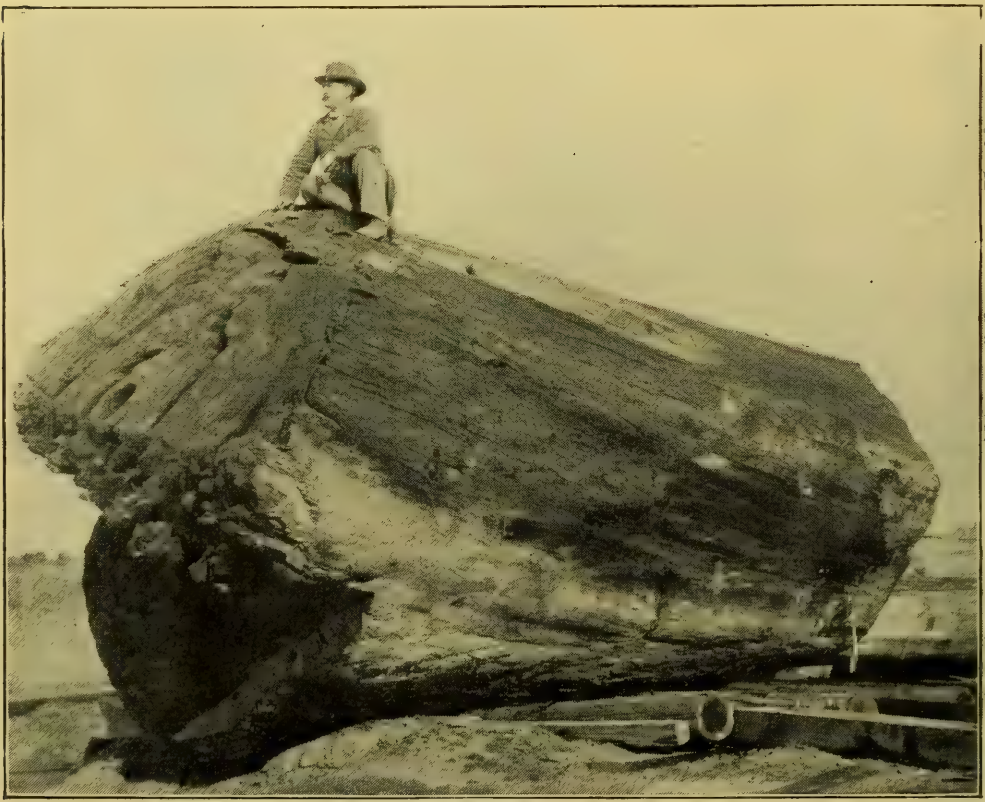
For the centering *a a*, bearing pieces for the truss on which the lantern is framed; *b b*, beam or girder of the truss; *c c*, upright posts which form the lantern. The four divisions in the plan show the timbers which fill up the spaces within the trussed frames *1 1*; *2 2*, purlins or cross timbers; *3 3*, firring for the outline of the dome; *4 4*, the bridging on which the boards are fixed for the lead covering. The trusses are of oak, the ends of the timbers being fixed in shoes of metal to preserve them from the damp of the stone.

MACHINERY AND POWER APPLICATIONS IN THE LUMBER INDUSTRY.

By William Adams.

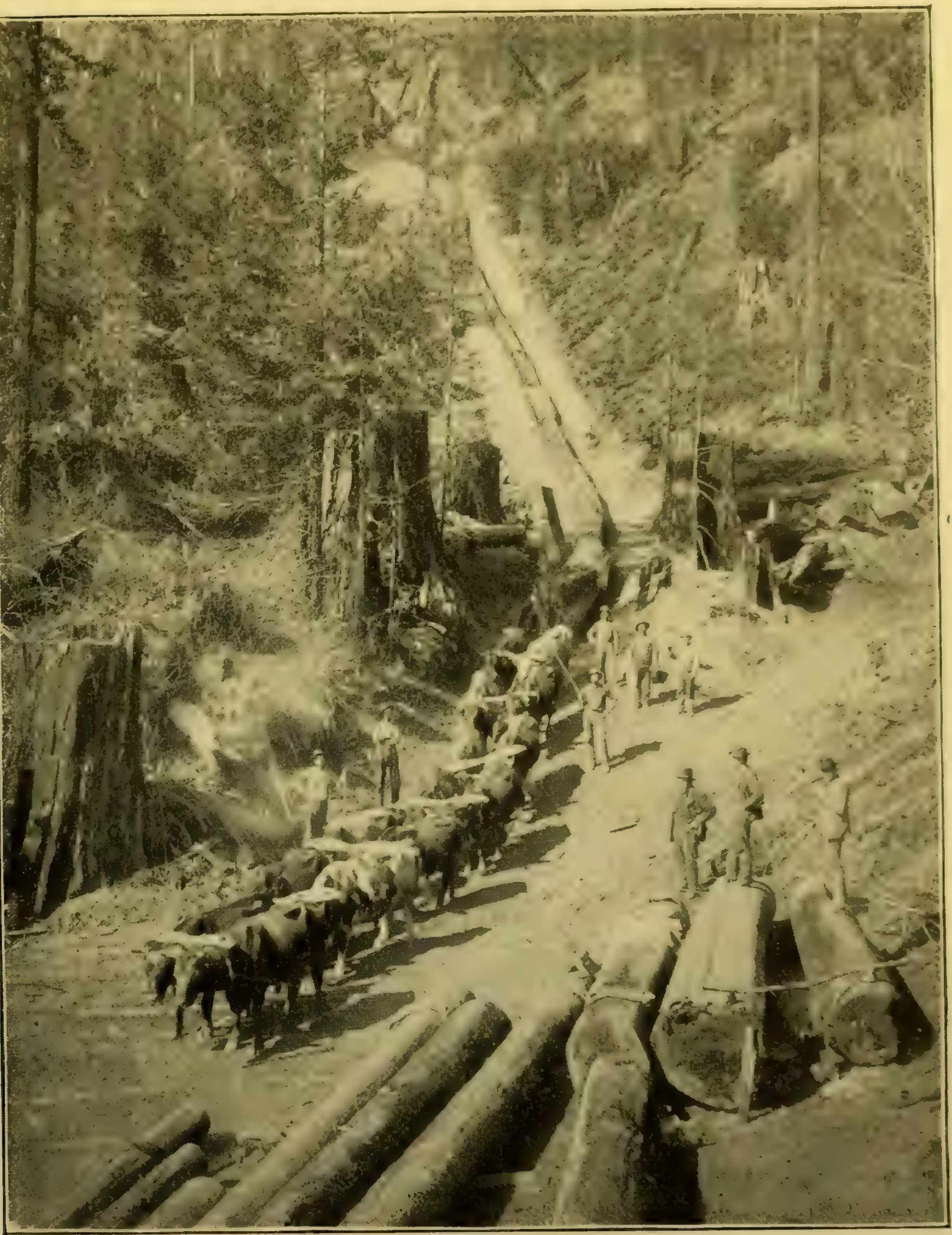
THE redwood forest belt of California extends along the coast range of mountains from the vicinity of the Oregon line southward about three hundred miles to the bay of Monterey. The redwood timber begins at the foot-hills a half mile to several miles from the coast, and extends back to the summit, and sometimes beyond, the width of the belt varying from ten to twenty-five miles. It is interspersed with fir of several species and with more or less tan oak, but the redwood covers most of the land. The winter rainfall is heavy on the summit—doubtless averaging more than sixty inches—and frequently falls in torrents, but there is seldom snow, and never more than a film. The streams are numerous and mostly short, the beds lying in deep cañons with steep, almost precipitous slopes. In early times logs were cut and rolled into the cañons, to be carried down to the mills by the sudden winter freshets. There were, however, but few streams where this was possible, and the timber which could be moved in this way was long since cut off. The entire belt is mountainous and deeply cut with ravines leading to the coast. The only method of getting out the logs is to get them to the bottom of the ravines, and thence out of the mountains. Occasionally, of course, there are small areas nearly level, but they are few and far between. The redwood grows to a very large size. The average diameter of the logs handled cannot be less than four feet; many logs have a diameter of eight or ten feet, and not infrequently butt logs twelve to fourteen feet through are seen. The problem of moving these enormous logs over rough mountain land, with the least possible expense and waste, has gradually developed many ingenious methods, which may be of general interest. The mill and logging camps at Fort Bragg on the Mendocino coast afford a fair example of redwood lumbering, and the methods described here are those in use in those camps, where, also, the photographs for the illustrations were taken. The methods are those developed by long experience.

The Noyo river, whose watersheds comprise the district referred to, is about thirty miles long, and has two main branches, the north and south forks; altogether the area drained is, perhaps, seventy-five square miles. In opening up a timber tract the mill is located at the most desirable landing place on the adjacent coast line, and, beginning at the point nearest the mill, the timber is cut clean, and hauled in over a railroad, which is extended as the work progresses. The track, as the foot-hills are reached, is laid at the bottom of a ravine; when all the land tributary to that gulch has been cut over, the track is removed to another; and so on, until the tract is cleared off. The woods crew inhabit rough buildings hastily put up with refuse lumber, which are abandoned when the work gets too far away from them, a new lot being then put up. These successive abiding-places are called "camps," and are numbered in the order of their rise and fall.



A TWELVE-FOOT BUTT LOG.

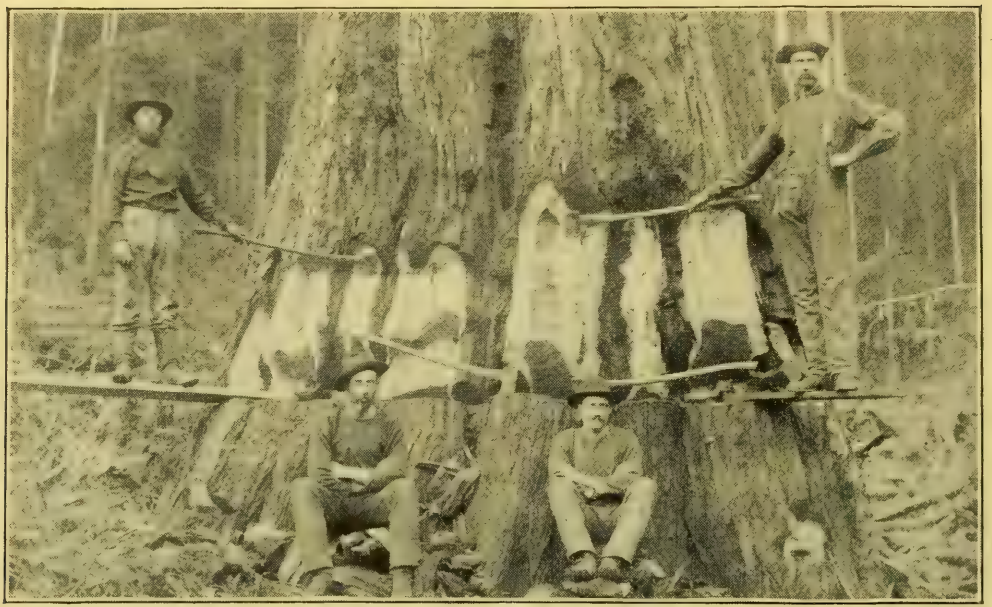
"Camp No. 7" is situated in the bottom of a gulch, or, rather, as near the bottom as possible, for there is not a foot of level land anywhere. It is a cluster of twenty-five or thirty rough-boarded, shake-roofed cabins of various sizes, but unvaried architecture, that appear to be clinging to the steep side hill with the grim tenacity of despair. So marked is their shaky appearance that it leads one to believe that their occupants must be possessed of a clear conscience, and the philosophic nature of the stoic or the fatalist, to sleep with restful composure in so uncertain an abode. Above the camp, clear to the top of the ridges on either side, are strewn the black bodies of the charred trees; and the air is filled with the shouts of the



A BULL TEAM IN THE REDWOODS.

loggers, the rapid "puff, puff," of the "donkey-engines" and "skidders," and the ringing scrape of the saws. Further up the gulch, from out the green foliage of the uncut trees, comes the sound of the steady, sharp strokes of the choppers, interspersed at intervals by the long-drawn-outcry of warning: "Look out belo-o-o-o-w!" or "up the hi-i-i-i-ll!" as the case happens to be, followed by the crash and roar of the falling tree.

The present methods of logging redwood, and the skill with which



BEGINNING A NINE-FOOT UNDERCUT.

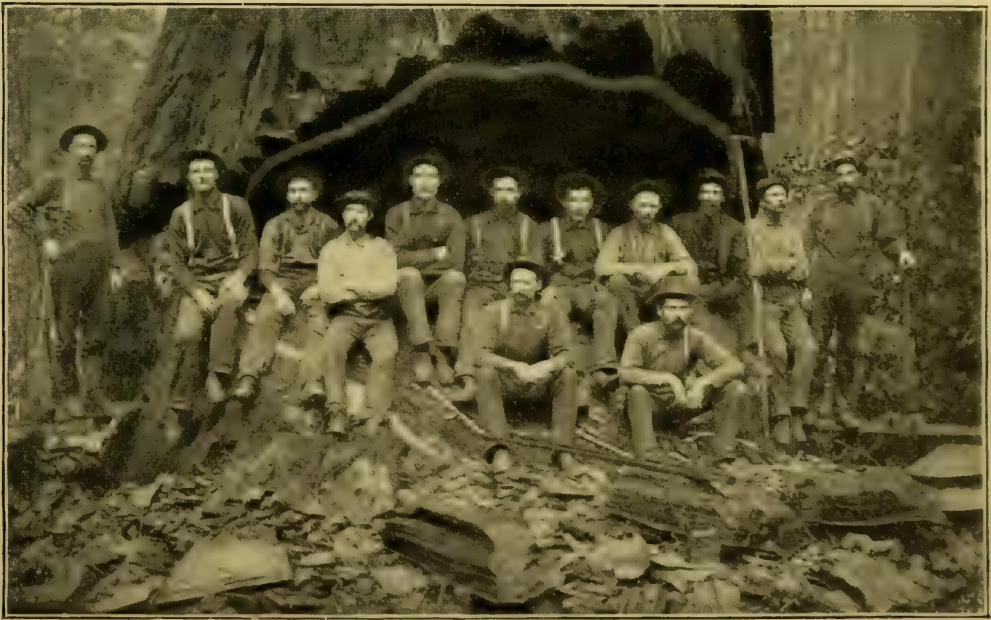
the work is performed, have not been developed in a day, but are, like those of most other enterprises, the result of knowledge gained by experience. And this is true in no greater degree in any other line of the work than in what seems the simple act of felling.

Fifteen or twenty years ago the amount of timber broken in felling was often so great that the good logs hauled away were hardly missed from the useless stuff remaining. Now, however, as the result of invention stimulated by competition, the work is accomplished with a rapidity little short of marvelous, and with almost no waste at all; a woodsman now must not only be a good axe-man and sawyer, but also be able to demonstrate his ability to "save timber," before he can procure a position as a "chopper" at the prevailing excellent wage.

The means resorted to in order to direct and control the tree in its downward flight are often most ingenious. The chopper approaches the tree, and, with the aid of a plumb line, ascertains how nearly perpendicular is its rise from its base; if the top does not lean more than two feet in the case of a large tree, or more than four in the case of a small one, he considers that he can fall it in any direction he may desire. He then views the ground, and selects the most promising "layout," and the "undercut" is made exactly facing it. If there are hollow spots in the "layout," they are filled up by felling small trees across and into them. The "undercut" usually extends about one third through, and then the tree is sawed in from the back to meet it. If the tree leans backward, a steel wedge is inserted in the saw-cut, as soon as the saw is buried in the wood, and, by frequently driving it, the saw is kept running freely. When the two cuts are within six inches of meeting, the saw is removed, and the tree is wedged up until the top passes the centre of gravity, when it falls by its own weight, easily breaking the strip of wood remaining. It often takes two men a half-day, and sometimes much more, to wedge over a large tree.

Occasionally a tree is felled up hill, where the surface of the ground is such that it is necessary for the butt and the top to strike the ground simultaneously. To compel this, the stump is snubbed off at the undercut, which provides a slanting surface, so that the butt has no place to rest, and perforce slides to the ground. In felling on level ground or down hill, however, this is unnecessary, as a tree will always give a bound after passing a certain angle, and fall clear of the stump. If the tree needs to be rolled off to one side, half the undercut is slanted, and a pile of chips is placed on the flat surface of the other half; the result never fails to manifest the efficacy of this device. Again, by leaving one side of the uncut wood between the undercut and the saw-cut thicker than the other, the tree may be drawn considerably away from its natural course. If space permitted, numerous other "tricks of the trade" might be mentioned, but the above suffices to show what is meant by controlling the falling tree.

As soon as felled, the trees are stripped of their bark; this, too, is a greater undertaking than corresponding work with other varieties of timber. At the butt the bark is from a foot to eighteen inches thick, though, of course, it is not solid, but, like most other heavy barks, more or less fluted. Hardwood wedges, a wooden maul, and



A FOURTEEN-FOOT UNDERCUT.

a twelve- or fifteen-pound crow-bar are used for this work. The top of the tree usually peels readily, but near the butt, where the bark is thick, the work taxes a man's utmost strength.

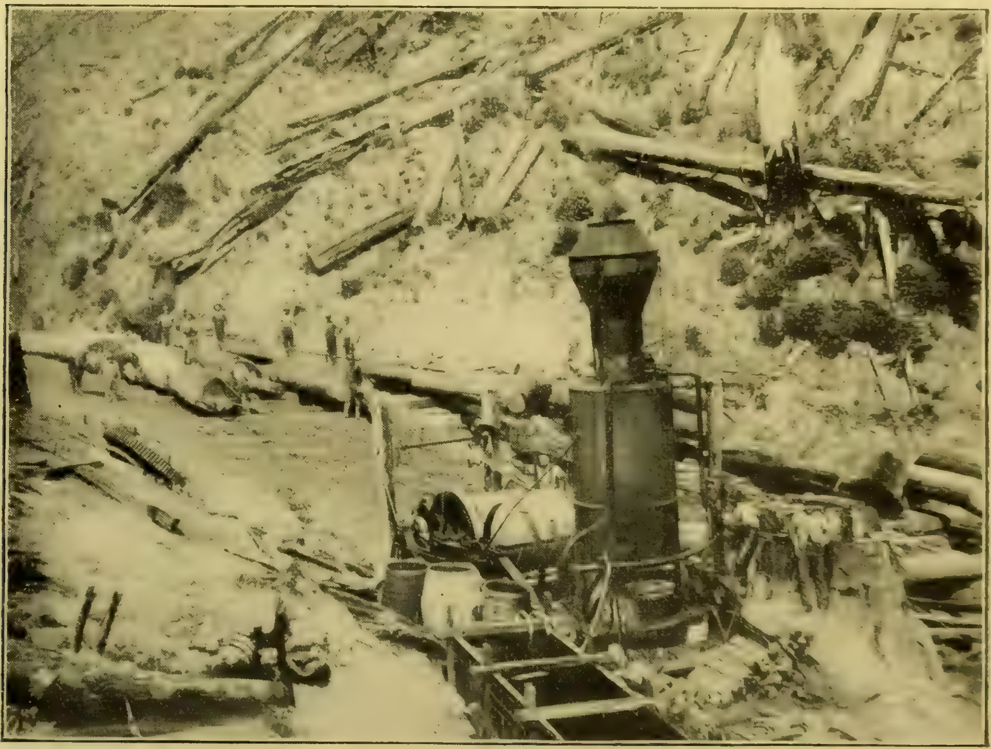
The choppers are kept about six months ahead of the loggers, in order that the timber and bark and underbrush may become dry; then fires are set throughout the chopped district, leaving nothing on the ground except the bodies of the trees too wet to burn.

Now, again, the "cross-cutters," who come to cut the trees into logs of suitable lengths, are met by problems of their own. They find the trees lying in every direction, on hillsides so steep that goats could scarcely climb them; and the wood is so springy and the trees are so large that it is only by utilizing every advantage that any progress is made. The writer, while working at "Camp 7," was once detailed to superintend the putting out of the fires which continued to burn after the brush had been consumed. This work has always to be done; else much valuable timber would be destroyed. The top of a fine tree was discovered burning, and it was found that the only way to save it was to saw the burning part off and roll it to one side. The tree had fallen across a small gulch, so that the ends rested on the ground, but the point at which it was necessary to make the saw-cut was suspended in the air. Two stout fellows were set to sawing it, and they soon had the saw buried in the wood. It then, however, began to pinch badly; wedges were driven in the cut to spread it, but this soon proved insufficient, and ere long the saw was well-nigh immovable. We were none of us sawyers, but we all set to work and braced and propped and pried right diligently, to little purpose however; presently one of the men, utterly worn out and discouraged, threw down his tools and demanded his wages, refusing to work any longer. The next morning the superintendent of the woods sent a single experienced sawyer, and he completed the work easily.

The cross-cutters begin their work at the mouth of the gulch, and keep only a few days ahead of the logging operations. Following them come the "swampers," who clear away what brush escaped the fire, and build the roads preparatory to hauling. Along the bottom of the gulch a substantial road is built, and skidded with small logs wherever the grade is not very steep; and up each of the tributary gulches roads are built with a care proportionate to the amount of hauling to be done over them.

But it is in the hauling that the most distinctive features of redwood logging are found. For this work it has been found expedient to utilize steam power; and so, instead of the picturesque oaths of the "bull-punchers," the visitor's ear is greeted by the puff of steam and the sound of running machinery. Oxen and horses are used only for small timber or by small mills. At the mouth of the gulch the skid-road is broadened out to form a landing from which to load the cars. It is usually large enough to hold perhaps fifteen or twenty logs, and at the lower end of this is placed a "skidder." These skidders are similar to the ordinary donkey-engines used on pile-drivers and around hoisting works, but are much larger, being of about seventy-two horse power. On them are two large drums, or spools, one just in front of the other.

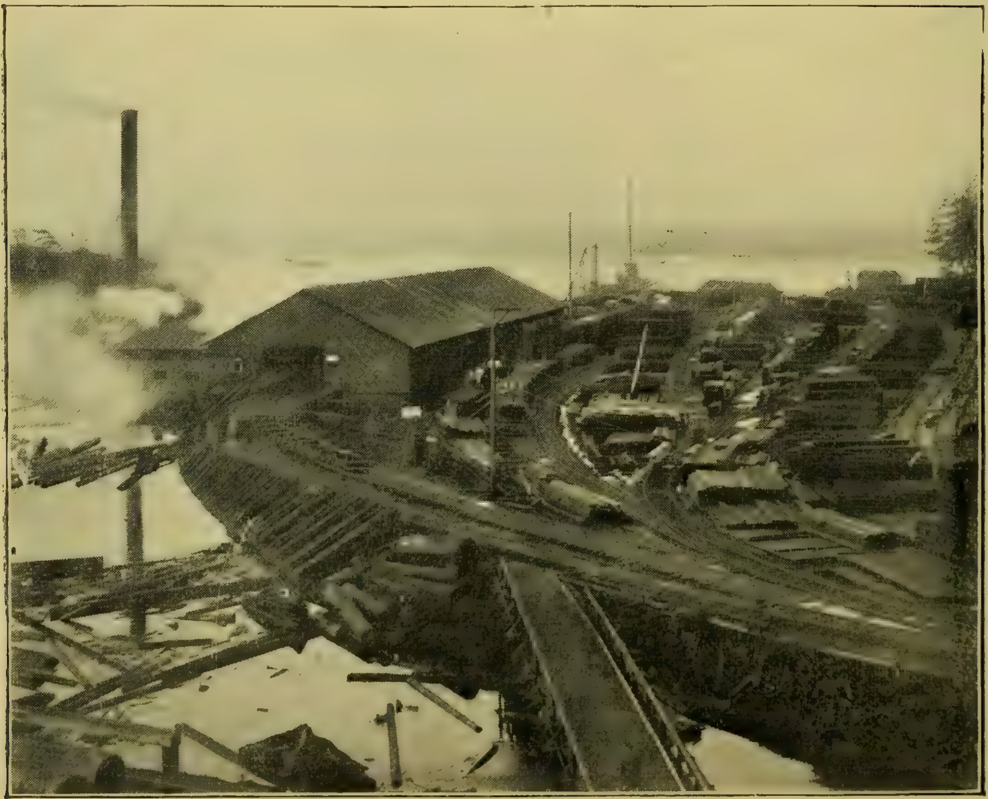
From the hind drum a one-and-one-eighth-inch steel wire cable runs up to the end of the main skid-road, and is attached to a half-inch cable, which passes through a pulley and then returns and coils around the forward drum. A string of logs is fastened together by dog-chains, and then the first one is hooked to the large cable. To the last log is fastened the end of the small cable, and a sled for use in returning the dog-chains to the woods. When everything is ready, an electric bell gives the signal to the engineer of the skidder, and the string of logs, from one hundred to two hundred feet long according to their size, is dragged along the corduroyed skid-road to the landing. At "Camp 7" the cable extends up the main skid-road about a mile. Wires for electrical communication with the engineer are laid along the skid-road, and the signals are transmitted by merely breaking the wire at any point and scraping the two ends


A SKIDDER AT WORK.

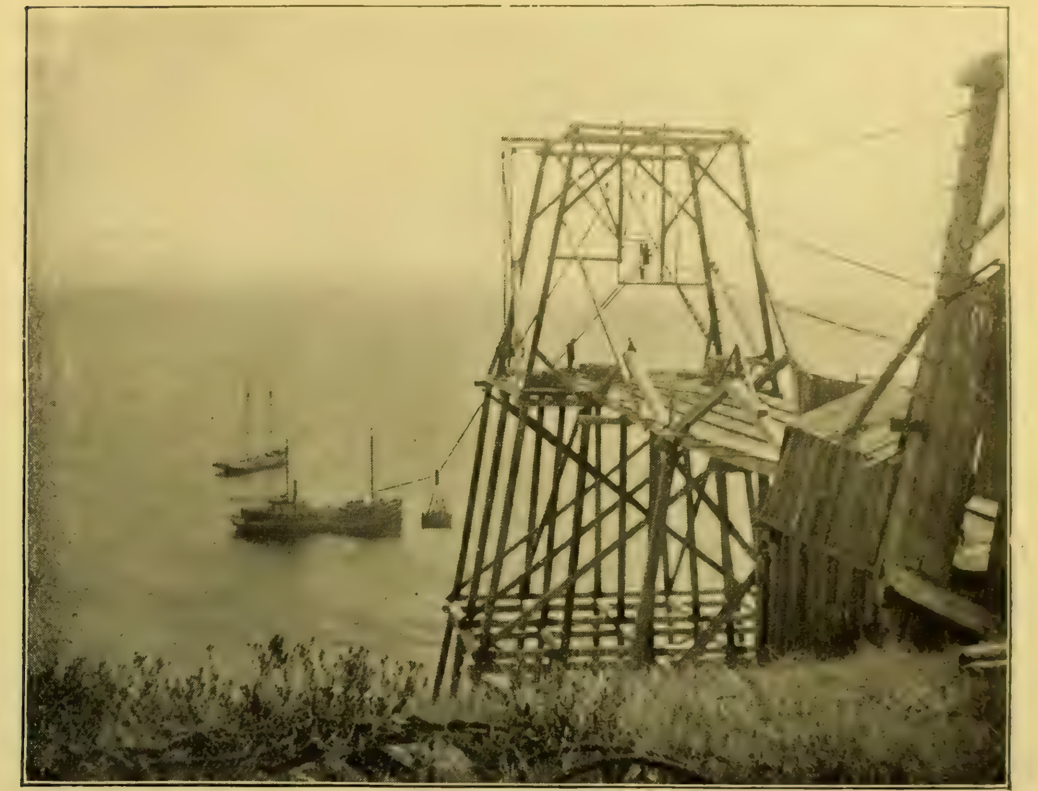
together. The small cable is dragged back to the skidder, where it is run over its drum and used to again carry back the main cable to the end of the road.

Each skidder is supplied with logs by one or two donkey-engines of about twenty-five horse power. They are built on runners, and are made to haul themselves about by attaching them to their own cables. Instead of the large drum which characterizes the skidder, they are provided with a small spool ten inches or a foot in diameter. The surface of this spool is made very concave, so that the coils of the cable will draw together and bind when wound about it a few times. These donkey-engines are supplied with but a single wire cable about three-fourths of an inch in diameter and three hundred or four hundred feet long, having a large hook at one end.

To move the engine to its field of usefulness the "line-pullers" grab hold of the hook and drag the cable its length in the direction in which it is desired to go, and fasten the hook to the nearest stump. The "spool-tender" then takes a few turns around the spool with the other end, leaving just enough for him to pull on to draw the coils tightly together in order to make the cable bind. The engine may then be drawn up to the stump, when the line may be



LUMBER MILL, YARDS, AND WHARF AT FORT BRAGG.



LOADING BY A STEEL-WIRE CABLE.

carried on and the operation repeated until the engine is in place. It is really astonishing to see one of these engines crawling up a steep sidehill as if it had legs. When the engine reaches its destination, it is fastened securely with guy-ropes, and then the real work begins. The line is carried out and hooked on to the logs, which are pulled out from among the stumps and started towards the main road, when they are taken up by the cable of the skidder and dragged to the landing. By passing the line through steel pulleys attached to stumps or roots, the cable may be made to pull around corners or in any direction; and sometimes, when an enormous butt log is to be moved, the line is passed through an elaborate system of these pulleys, some attached to the log and some to near-by stumps, to obtain all the advantage possible. Supplementary to the donkey engine and its crew of workers are the "jack-screwers," who go along the sides of the gulches and start with jack-screws any logs which can be moved in that way; these will continue to slide or roll, when once set in motion. Where the sidehills are steep and the trees are not too large, much timber can be got to the skid-road in this way. The capacity of a skidder varies, of course, with the length of the haul, but it averages, with the aid of one donkey-engine, about seventy thousand feet per day; with two donkey-engines, about one hundred and twenty thousand feet per day. The average scale of the logs is about one thousand feet per sixteen-foot log, but logs are frequently cut which scale as high as seven thousand feet. Three skidders and five donkey-engines are constantly at work at "Camp 7," and, in addition, they have one ten-horse team and one or two ox teams at work at the lower camps.

When the logs reach the landing, they are rolled with jack-screws and cant-hooks on to the cars, or "bunkers," as they are called, on which they are hauled to the mill. These bunkers look like half of an ordinary flat car with a big iron-shod pivotal bolster running across the middle of it. Two bunkers coupled together constitute a car, and the logs are loaded on them by resting one end on the bolster of one bunker and the other end on the bolster of the other. By providing coupling-irons of different lengths, the bunkers can be arranged to fit logs of any length. Much care has to be taken in loading the cars to see that the load is well balanced; else there would be great danger of mishap, for the road-beds of logging railroads are not of the smoothest, and many of the turns are very sharp. Some of the logs are so large that a single one will render a car top-heavy.

A BREAKER ON A PACIFIC HARBOR BAR.

The rail road is of standard gauge, and the locomotives used are similar to the ordinary switch-engines, but are designed for this special work, being low and of simple construction.

It is rather a thrilling experience to ride from camp to mill on a load of logs. The bunkers are not provided with springs, and long service on rough roads has somewhat inclined the engineers to recklessness. To a person taking his first ride it becomes an open question with himself whether or not he will reach the mill alive ; and indeed often, as the car drops into a chuck-hole and then bounces out again, and sways far over from side to side, and pops around corners like the tip of a cracking whip, he will become convinced that it is about to be decided in the negative. Reaching the mill, the logs are dumped into a pond, whence they can be dragged as needed.

The mill at Fort Bragg is one of the largest and most complete mills on the Pacific coast, and is designed not merely to convert the logs into rough boards and timbers, but to provide the market with every product of lumber. In fact, there are many practical millwrights who contend that the mill is so overburdened with complicated machinery as to occasion much confusion and consequent waste.

The mill has two main saws,—one of the double circular type, having a six-foot cut, and the other a band-saw capable of cutting a log ten feet in diameter. When the logs are more than ten feet in diameter, they are split in two by putting a small blast of powder in the side of them before they are brought into the mill.

To rip up the cut which leaves the main saw, a "gang" edger is used ; it is fifty-six inches wide, and will cut a slab eight inches thick. It contains six saws that can be shifted at will to cut any width of board. From the edger the lumber is carried on rollers to the lumber-yard or to the surfacer, where it is converted into the finished product in its various forms. There are also shingle and lath machines, etc., each of which produces quantities of its particular specialty. About one hundred and twenty-five thousand feet of lumber is an average day's work for this mill.

This vast amount of machinery is run by two common slide-valve engines of seven hundred and seventy-eight horse power each, which are of heavy construction and rigidly plain.

The mill is built a short distance from the water's edge, so that lumber can be loaded on hand-cars and run out to the wharf ; a gentle downward slope of the track greatly facilitates this proceeding. From the wharf the lumber is picked up with a derrick, a thousand feet at a time, and swung over on to the vessel as fast as it can be stowed away. A double-cylinder hoisting engine is used for this purpose, and the apparatus is capable of handling five hundred thousand feet of lumber in twelve hours.

The Fort Bragg harbor, while one of the best on the Mendocino coast, is not by any means an ideal one. The water being shallow, the harbor is accessible only to vessels of light draught, and to attempt to enter the narrow, crooked channel, lined on either side with treacherous rocks, is an exceedingly hazardous undertaking in stormy weather.

For loading deep-sea ships the lumber must be taken about a mile to the mouth of the Noyo river, where the depth is sufficient, although the harbor is not so well protected. The method of loading at Noyo is the one now generally adopted where the sea coast is bold and where wharves cannot be maintained, but possibly it is not used anywhere on the Atlantic coast. The work is accomplished by means of a steel-wire cable stretched from the high bank to the vessel. A pulley-wheel, called a "traveller," is run on this cable, from which is depended the load of lumber in a sling of chains. The force of gravity carries the load to the ship, and then the traveller is hauled back by a donkey-engine. About one hundred and fifty thousand feet of lumber per day can be loaded at Noyo in this way. This cable method of loading is the most common along the Mendocino coast, as there are very few points where the harbor is sufficiently sheltered for a wharf. Indeed, in many cases there is no harbor at all, but the cable is run directly out to the open sea.

It has been recently estimated that seventeen billion feet of redwood lumber remain yet to be cut; under present conditions it will last thirty to forty years.

To one visiting these great logging camps and mills, the like of which do not exist elsewhere, perhaps the greatest impression carried away is of the wanton, needless, almost criminal waste of wood and lumber. The only idea which appears to actuate the lumbermen is to utterly obliterate these magnificent forests as speedily as possible. It seems hardly right that two or three generations shall be permitted to dissipate in a few short decades this splendid heritage. In spite of the ravages of axe and fire, the redwood, when cut, does not die. From the roots there at once springs up a dense miniature forest, which within twenty-five or thirty years produces trees that anywhere else would be considered of good size. This second growth, however, is brittle and knotty, partly because of the dense growth compelling dozens of sprouts to struggle for the sap from one stump. If these sprouts could be judiciously thinned out from year to year, and the strength concentrated in a number of trees no larger than that which originally occupied the ground, the quality of the second crop would be greatly improved. Present owners might do this, if only the cost of thinning had to be considered; but that would be a trifle compared with the expense of protecting from fire for the first ten years. With that to be considered the owners will do nothing. Some plan should be devised for so conserving what is left that posterity may get as much as possible out of it.

THE EVOLUTION OF SAFETY IN RAILWAY TRAVEL.

By Charles Hansel.

THE engineer is the pioneer of modern civilization, not only in opening new parts of the earth for settlement, but in leading the progress, developing the resources, and increasing the comforts of older regions.

The industrial systems of the great progressive nations stand as an expression of his genius, larger even than the concrete embodiment presented in their products. But probably no manifestation of his work is more impressive, in extent, dignity, diversity, or economic influence, than the great transportation systems which are breaking down national isolation and mingling the thought, as well as the substance, of different lands.

Advance may be rhythmic, rather than unbroken—or, rather, while advance continues, its expression may change.

The progress of one generation may even appear the obstruction of the next; this is vividly illustrated in the evolution of commerce between Liverpool and Manchester, the example being taken as illustrating the progress of transportation and the birthplace of the railway.

Manchester, situated on the Irwell, finds in Liverpool, on the Mersey, its natural port. The first organized scheme of transportation between these two points, and perhaps the first in England, was known as the Irwell and Mersey River Navigation Company. The system of carriage was navigation of the Mersey and Irwell rivers. In 1757 the population of Manchester and its environments was only 20,000. The imperfect state of the roads and the uncertainty of travel by river rendered it difficult and exceedingly expensive at some seasons for so large a population to provide themselves with food and coal. There was no connection between the collieries situated at the east of Manchester and the Irwell or Mersey, and the charge for cartage between Manchester and Liverpool by the Irwell and Mersey River Navigation Company was no less than forty shillings a ton.

These conditions existed when the duke of Bridgewater commenced the building of a canal from Worsley to Manchester, which was the beginning of the enterprise that gave Manchester its first certain connection with Liverpool, and was the first of England's navigable canals. The completion of this canal to the tidal estuary of the Mersey was naturally impeded by the opposition of the Irwell and Mersey River Navigation Company, which saw its monopoly assailed in this new method of transportation. Notwithstanding this opposition, the canal was opened in 1773, establishing water connection between Manchester and Liverpool,—a truly magnificent undertaking, nobly planned and skilfully executed; although in the early stages of construction the people called this canal "The Duke of Bridgewater's Folly," the financial returns established its value as a commercial enterprise, and showed from the first the necessity for building it.

The business of Manchester increased so rapidly with the opening of this canal that it was found necessary to provide additional means of transportation to Liverpool. Cotton lay at Liverpool for weeks, awaiting shipment, and it frequently required more time to transport cargoes from Liverpool to Manchester than from the United States to Liverpool. The canal was overcrowded with business, and the charge for carriage between Manchester and Liverpool had been reduced from forty shillings per ton to eight shillings, and the poor, decayed town of Liverpool of Queen Elizabeth's time had now become the principal seaport of the kingdom. This marks the second epoch in organized transportation.

We find that, when the duke commenced the construction of his canal, he had to contend with the fierce opposition of the Irwell and Mersey River Navigation Company, which at that time had the monopoly of transportation beween these two cities. The completion ot the duke's canal placed him in the position of chief conspirator to secure the good of the community, commonly called a monopolist, and, as the increased commerce overflowed the channel of his canal, there appeared upon his horizon the dawn of a new era of transportation, which marks the third and most important epoch in this history of internal improvement.

At Edge Hill in October, 1829, there gathered a crowd to witness the triumph of the "Rocket" of Stephenson over the "Novelty" of Ericsson, the "Sanspareil" of Hackworth, and the "Perseverance" of Burstall. No throng at Doncaster to witness the St. Leger has ever equalled the gathering at that iron track to witness the performance of a power that now tallies the miles by the second hand. It is interesting to note that the "Rocket" of that day possessed all the principles of the express locomotive of to-day. We refer to the tubular boiler, forced draught, outside-connected horizontal cylinders, and the reversing mechanism.

The duke of Bridgewater was compelled to fight his canal through parliament against the prejudices of the people; he in turn became a monopolist, and the third epoch marks Stephenson, with his "Rocket," pointing the way to the new era of civilization. Opposed to him we find the progress of the preceding generation headed by the duke of Bridgewater, and, when Stephenson proposed to carry persons at the astonishing speed of twelve miles per hour by using the locomotive, the opposition and prejudice met by the duke of Bridgewater was multiplied by the opposition of nearly every individual. He stood alone, in contradiction of the best judgment of the foremost engineers of his time, and, without the monument of previous success to sustain him, but by his genius and perseverance, he planned and constructed the first iron highway between Manchester and Liverpool, which has expanded to not less than 555,500 miles, bringing the people and nations of the world together. The cost of carriage has been reduced from eight shillings a ton (on the duke of Bridgewater's canal) for the thirty-five miles between Manchester and Liverpool to less than one shilling a ton on the fourteen lines of railroad connecting Manchester and Liverpool.

Great Britain, with an area of 89,222 square miles, 58,320 of which are in England and Wales, had, at the time the first railway was opened, a population of 16,400,000. The cotton, woolen, and silk mills of Lancashire, Middlesex, Surrey, Kent, Gloucester, Hereford, Yorkshire, and many other manufacturing centers were busy with a great industry. More than two hundred silk mills were in operation, and the looms of Manchester alone consumed 264,000 pounds of cotton, most of which came from America. The shipbuilding on the Clyde and the steel and iron mills of Leeds and Sheffield were then great industries, and there were 2,300 miles of canals in successful operation.

The first railroad engineers of England followed their profession at great personal danger, owing to the fierce opposition of the English country gentlemen to innovations in methods of conveyance and the superstitious prejudice of the commoners, and this feeling of local opposition was also an important factor in the heavy cost of construction, as every foot of right of way was purchased at a conciliatory figure, or condemned by process of law which resulted in exorbitant values. But, while the building of railways in England was attended by great cost, it was assured abundant patronage from the great manufacturing industries, whose product then overflowed the existing channels of commerce.

The preference of the commoners for the slower and more familiar methods of transportation by canal and stage, founded on superstition and supposed self-interest, made it necessary for the railways to offer special inducements to secure traffic which had heretofore followed the canal and stage, notwithstanding the fact that the railway offered cheaper and quicker transportation and the business of the country was overcrowding existing channels. As a means of inducing the people to favor this new mode of transportation, the railways offered to cart freight free of charge to the shipper, and this concession to the more primitive means of transportation has resulted in a branch of railway service in Great Britain which is found nowhere else. It has compelled railways to build immense warehouses, purchase thousands of draught horses with their attendant carts, harness, etc., and build large stables and veterinary hospitals; and, as an illustration of this branch of service, unknown in the United States, one railway operating but five hundred miles is required to employ at one important freight terminal twenty-one hundred men and eight hundred horses, made necessary by the free delivery of freight to and from their patrons and the warehouses.

The United States of 1830 numbered twenty-four States, the District of Columbia, and the three territories of Michigan, Arkansas, and Florida, with a total population of less than thirteen millions, of whom two millions were slaves. The vast territory west of the Mississippi was unexplored, and the railway development in the United States has had to adapt itself to a new and rapidly-developing country. While the American engineers were not attacked by the commoners or obstructed by the nobility, they found greater difficulties, for they were compelled to accomplish their surveys and construct the railways through a country inhabited by a savage foe. Moreover, instead of finding an ample commerce ready for the railroad, it was necessary to foster new industries and wait for their development.

Notwithstanding the great obstacles to the location and construction of the railways, there have been built in the United States, since the opening of the South Carolina Railway of 1830, no less than 186,500 miles, the construction of which has employed hundreds of thousands of men and hundreds of millions of money, and has brought the charge for carriage to less than one-half a cent per ton per mile.

Looking eastward, we see in "Darkest Russia" the construction of the great Trans-Siberian and Manchurian railways, bringing the capital on the Baltic and the Holy City of Moscow to the Japanese sea at the port of Vladivostok, and to the ice-free Yellow sea at Port Arthur, crossing the border line between Siberia and China at Stretinesk and making the ports of Vladivostok and Port Arthur an integral part of the great Russian empire.

Coincident with the extension in mileage has been the improvement in condition, in management, and in speed and safety of travel. The equipment of trains for passenger service in the United States is more luxurious than that of any other country, and the comfort and security assured to the traveller remove from his mind all thought of danger.

It is not sufficient to provide luxurious equipment and commodious passenger stations, and it requires much less expenditure to perfect this branch of the railway service than to furnish a permanent way safe for the passage of trains at tremendous speed. The luxuries of yesterday become the necessities of to-day, and safety appliances which by many were considered luxurious refinements are the means by which railway travel has been made safe.

The safety of railway travel is emphasized in a practical way by the action of the several insurance companies of the United States, which have found that the danger incident to railway travel, or travel on any common carrier, is so minimized that they offer policies providing for the payment of twice the amount if the holder is injured or killed while travelling by any common carrier.

The statistics for the past twelve months show that the railways of the United States carried 550,000,000 passengers, that one passenger was killed for every 2,250,000 carried, and that one was injured in every 4,500,000 miles of travel.

The locomotive taught us how to go, and the air brake taught us how to stop, and it was soon found of equal importance to know when to go and when to stop. This necessity has brought about a new field in the industrial art, and has established a profession called "signal engineering," which has become an important department of railway service. Railway officials who have won position by faithful and intelligent service, guarding alike the interests of the public and the property in their charge, and having a clear insight into the multifarious interests and the safe and successful conduct of their business, are the first to acknowledge the necessity of guarding every point of danger. It has been found necessary, however, to aid them by invoking the power of the law to compel railways to adopt certain approved appliances for protection of life and property; and, since the necessity of being able to stop and of knowing when to stop is the first requirement of safe operation, federal and State legislation has been enacted in the United States, requiring the adoption of the air brake and signaling devices for the guidance of the engineman and trainmen.

The introduction of the air-brake, perhaps the most important safety-appliance in railway operation that has been designed and perfected, solved the problem of how to stop. But it is not necessary to explain its operation, the general principles whereof are understood by the travelling public.

When the Liverpool & Manchester line was opened, the speed of trains was limited to twelve miles an hour, although the "Rocket" demonstrated its ability to travel thirty-five miles an hour with three coaches. The first scheme for guarding against collisions was the introduction of a horseman armed with a flag who preceded the train; after this came guards stationed at intervals along the track within visual distance, whose duty it was to notify the approaching train, by hand signals, that the preceding train had passed the next station.

As the speed of trains increased, it was found unsafe to rely, as formerly, on the flag or lantern in the hands of men stationed along the line. It became necessary to devise means of advising the engineman what to do, in language admitting of but one interpretation, —stop or advance. Moreover, the message must be given in advance of the approaching train, and, once given, it must be beyond the power of the signalman to change it until it has fulfilled its office.

While it is desirable to separate the grades where one railroad crosses another, it involves great expense, and interferes with the convenient interchange of business. For these reasons we find that in the United States the majority of crossings are made on a common level. The principal dangers of railway operation, outside of the physical condition of the permanent way, are found in the crossing of the tracks of one railway with another at the same level, the junction of one railroad with another, the collision of trains on the main track, the crossing of navigable streams requiring a drawbridge, and the introduction of passing tracks. Since no official public reports are made on the accidents which occur in the United States, it is impossible to illustrate the value of protecting these points of danger by a suitable system of signals, but that such protection is necessary is conceded by all railway-operating officials.

The police regulations in the majority of States require that a train shall come to a full stop within a certain distance of any crossing or junction before proceeding over it; if this law was observed, there would be little danger of accident at grade-crossings or junctions. But such stopping entails an operating expense, and is the source of much delay and annoyance. Consequently trains pass over these crossings at high speed, at the risk of a heavy penalty. It has been demonstrated that all crossings, junctions, drawbridges, and passing tracks can be completely protected against collision or accident, and consequent loss of life and destruction of property, and that this protection not only facilitates traffic, but materially reduces the cost of operating; and thus, aside from the desire to protect human life, the possibility of saving time and cost offers a sufficient inducement to the railways to introduce these safety-appliances.

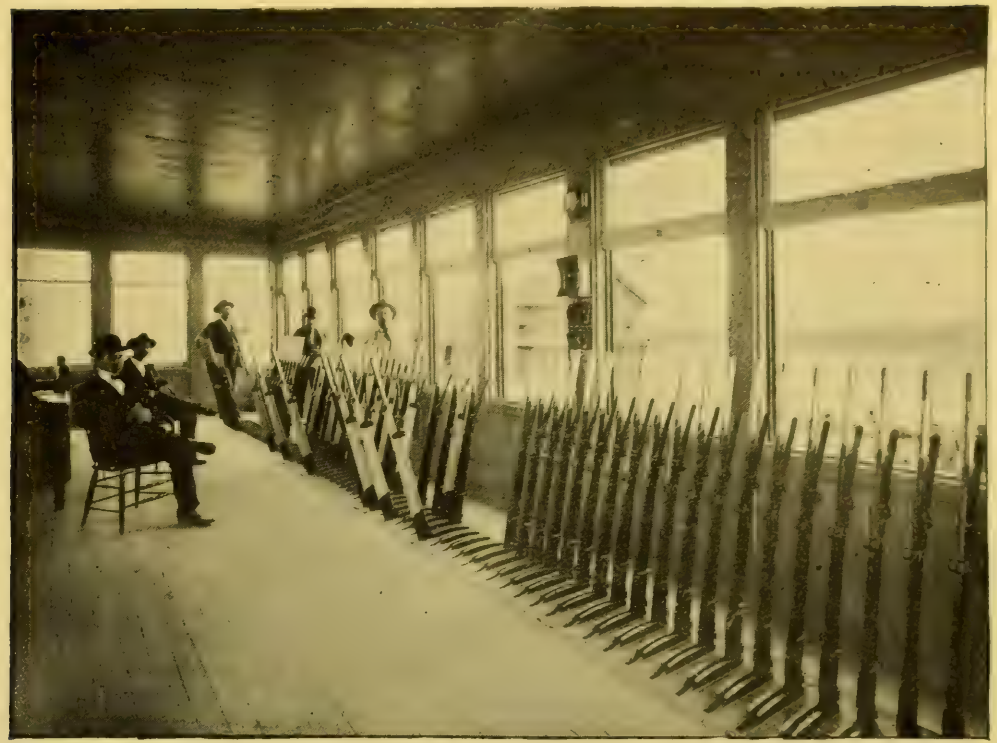


FIG. I. OPERATOR'S FLOOR IN A 68-LEVER SIGNAL TOWER AT SHORB, CALIFORNIA.

Several of the States have enacted laws providing that, if a railroad crossing at grade, a junction, or a drawbridge is protected with signals which make it safe for the railway to operate trains over such points without first coming to a full stop, the trains may be so operated, and the law requiring them to stop at such grade-crossing is declared inactive as to the particular crossing, junction, or drawbridge so equipped. The methods of designing and installing a suitable system of signals for the protection of crossing, junction, drawbridge, or passing track, while differing in detail, necessarily involve a universal principle of safety, which may be described as follows: a system of operating switches, crossings, and signals in such a manner as to make it impossible for the signalman to bring about an accident by careless or ignorant manipulation.

Without going into details, it is sufficient to say that all switches and signals within the limits of a defined area are controlled by a machine at a central point in charge of a signalman, and that the operating mechanism in his charge is so arranged as to require him to operate the signals in proper sequence, the result being that he cannot give signals which will authorize an engineman to proceed where there is any possibility of collision with a train on the opposing route.

The mechanism which enables the signalman to control these switches and signals is located in a signal cabin at a convenient point, generally near the crossing, junction, or drawbridge, and the principle upon which it is operated is similar to that of a combination safe-lock, requiring him to manipulate the machine according to a predetermined plan. In case he fails to follow this plan, he may delay traffic, but cannot cause an accident.

Fig. 1 is an illustration of the interior of a signal cabin, showing the levers by means of which the operator is placed in direct connection with and control of the several switches and signals. The interlocking mechanism by which the movement of these several levers is controlled is below this floor. This signal cabin is located at Shorb, Cal., a very important junction point on the Southern Pacific, within a few miles of Los Angeles. There are sixty-eight levers, and by them all the switches and signals are operated. All train movements are made at this point without switch-tenders, not only facilitating the movement of traffic with absolute safety, but also avoiding the danger of accident to employees. In addition to the safety secured by operating all switches at a crossing or junction from a central point in the manner described, great economy of operation is effected, especially at busy terminals and at points where the gradient of the road is such that, if trains were compelled to stop for the crossing, it would not be possible to draw trains as heavy as those which can be drawn without stopping.

Fig. 2 illustrates the entrance to the passenger station of the Union Railway at Troy, N. Y. The signal cabin in the foreground, located on a steel bridge spanning the tracks, controls all switches and the signals indicating their position for the entrance of trains into the station. A similar cabin is installed at the opposite end of the station, and these cabins are so connected as to require harmonious action on the part of the signalmen in charge. There is an ascending gradient to the north. This system of signaling renders it unnecessary for a freight train to stop on this grade, and, consequently, heavier loads may be carried, while at the same time traffic is moved with greater speed and absolute safety. The signals for trains leaving the station are carried on a bridge across the portal of the train-shed. In the illustration all signals are in the danger position, except the upper arm of the right-hand signal at the signal cabin on the bridge. This position indicates that a north-bound train on the ascending grade has right of way, and all opposing trains are blocked against it.

The control of a drawbridge with a grade-crossing near the end of it is illustrated in Fig 3. The Illinois river is crossed at this point by a bridge about one thousand feet long, including a draw span of three hundred and fifty feet. The danger to traffic at this point is unusually great, as the trains of six companies are compelled to cross this bridge to secure entrance to Peoria. An interlocking plant has been established at this crossing, which not only controls the movement of the drawbridge, but provides that, when a train has received a clear signal to advance over it from either end, no opposing train can reach the crossing; nor can the engineman on the drawbridge operate his engine or unlock the bridge, until the entire train has passed over and beyond the crossing.

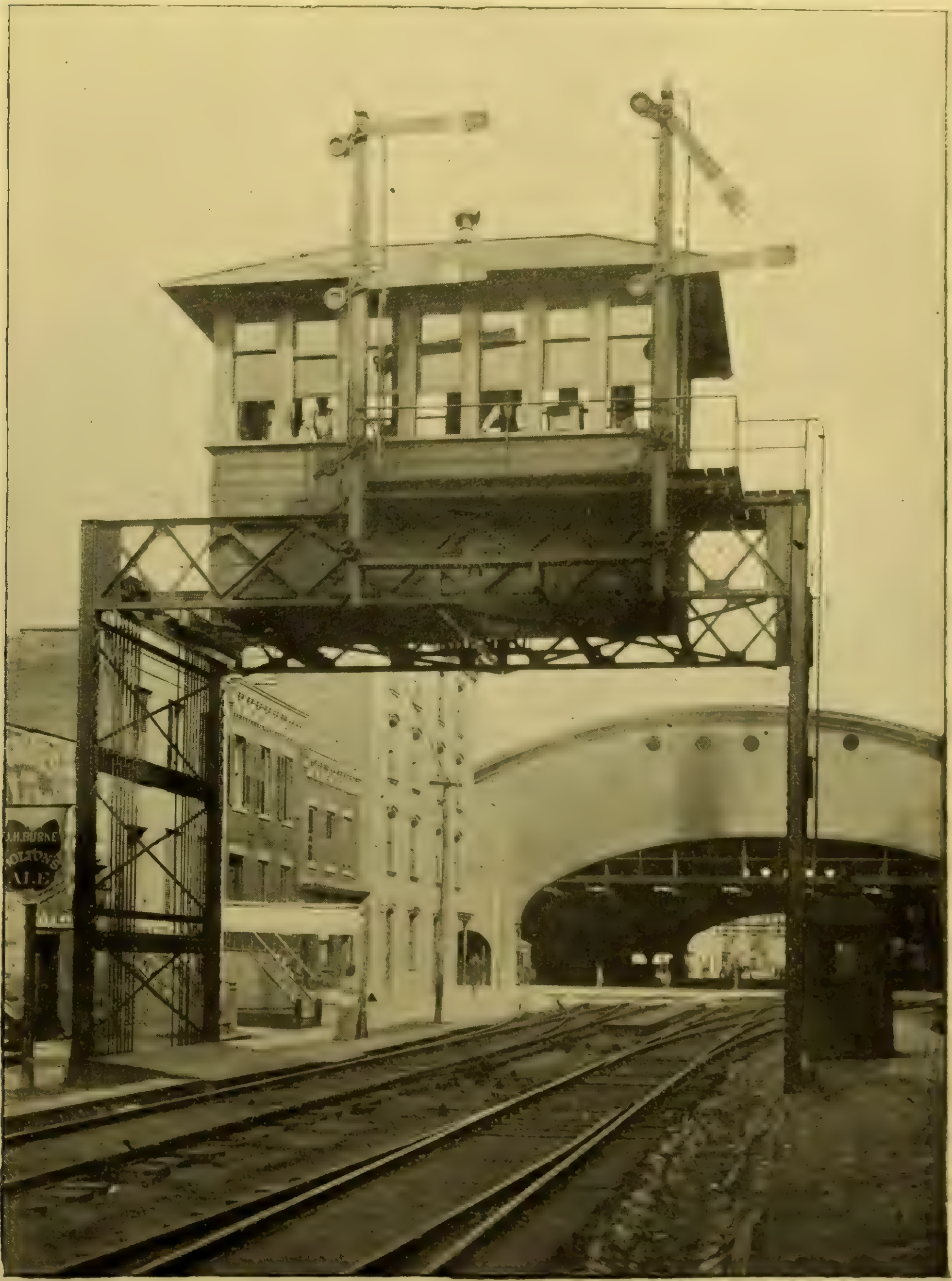


FIG. 2. SIGNAL TOWER PROTECTING A THROUGH STATION. TROY, N. Y.

While the crossing of two street railways is not as hazardous as a crossing of two steam railroads at grade, and while the crossing of a street railway with a steam railroad may not be considered as hazardous as the crossing of two steam railroads at grade, it must be held that the crossing of the tracks of two or more lines of railway, be it of a steam railroad with a steam railroad, or of a steam railroad with a street railway or other secondary railway, must ever present great danger to human life, unless so protected as to make it impossible for trains or cars on either road to reach the crossing at the same time. The present tendency is to increase the number, as well as the mileage, of existing lines of street railways throughout the United States, which cannot be done without crossing and recrossing the tracks of existing steam railroads.

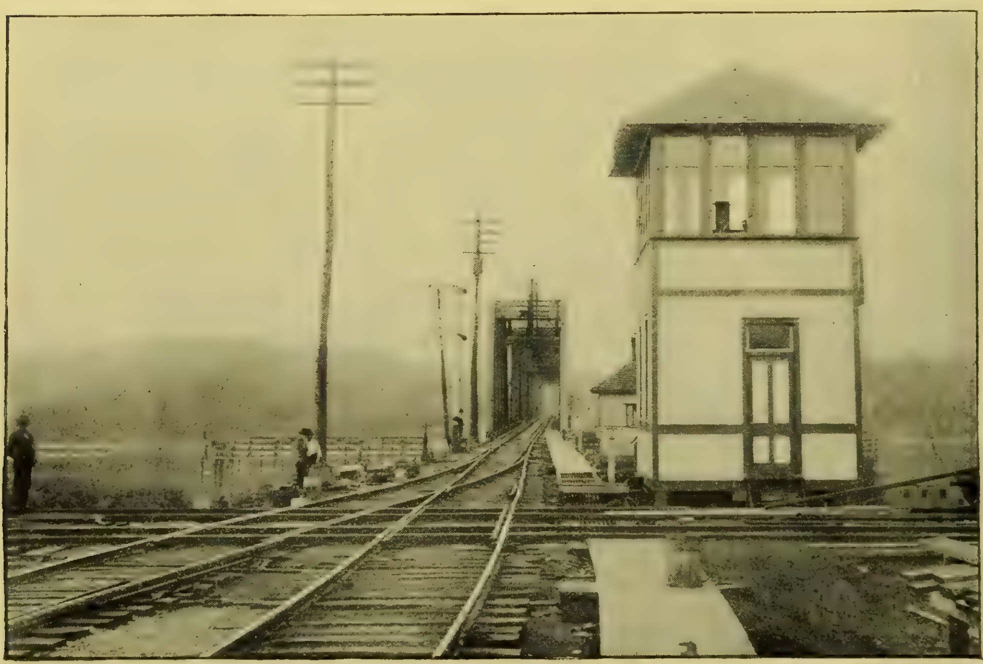


FIG. 3. SIGNAL SYSTEM PROTECTING A DRAWBRIDGE.

The same general appliances may be used for all railways at grade, no matter what the motive power. An additional safeguard may be secured where a steam railroad is crossed by an electric street railway, by so arranging the mechanism that the current is cut off from the electric car at a distance from the crossing, so that, if the motorman fails to see that the signal is against him or disobeys it, he cannot reach the crossing, the car having no power.

The method of guarding against the collision of trains on the main track where there is no crossing or junction is almost the same as that used for the protection of grade-crossings or junctions, the difference being that the mechanism for controlling the signals which govern the movements of trains is so involved with the signal cabin on either side as to require the co-action of two signalmen at points some distance apart in order to clear a signal which will give a train authority to proceed over the track between the two signal cabins. By requiring the united action of these signalmen at both ends of the section of track, protection is secured against errors which might occur if the signals were in the control of one man; the signalman receives definite information as to the movement of trains at either side of his station, and, in case he has authorized the train to advance to the next signal cabin ahead, he is not at liberty to give the same authority to a second train without the consent and co-action of the signalman in advance, which cannot be given until the first train has passed the cabin in advance, thus making it safe to issue an order for the second train to advance. By this means the trains are divided by space, and the maximum safety is secured.

The yearly record of train accidents shows that a large percentage of the loss of life and property is directly chargeable to "open switches." While it is possible in many cases to avoid the use of facing point switches on double lines, it is impossible to pass trains and serve industries on single-track lines without introducing this danger. These facing point switches are often made necessary by the requirements of passing sidings, and, as the word implies, the necessities of the traffic require these sidings, so that trains may be passed at such points; consequently it is expected that these passing sidings will be frequently occupied by a train, and, unless some provision is made whereby the switches from the main track will surely be closed and locked for the main track after a train has passed through into the siding, the approaching train will follow into the passing track, and a collision will occur.

The cost of protecting against this class of accidents as compared with the cost of installing a system of signals for the protection of grade-crossings or junctions is exceedingly small; as an example, twenty-five or thirty facing point switches may be protected at the cost involved in the protection of the simplest grade-crossing. There is no additional fixed charge for operating the protection installed for the facing point, whereas the operating cost of protection for the simplest grade-crossing is not less than $900 per annum. It therefore seems that, while the revenues of small railroads may not be sufficient to warrant them in installing signal plants for the protection of all their grade-crossings and junctions, there is no good reason why they should not protect and guard against accident at all facing point switches.

MINING THE IRON ORES OF ARCTIC EUROPE.

By David A. Louis.

IN connection with the meeting of the British Iron and Steel Institute, held at Stockholm last autumn, a most interesting excursion was arranged, by the Gellivare Mining Company (Aktiebolaget Gellivare Malmfält) of Stockholm, with the object of enabling a selected few to visit, inspect, and become personally acquainted with, the hyperborean iron deposits of Sweden, the operations connected therewith, and the associated circumstances and conditions.

The journey northward from Stockholm as far as Gellivare, a distance of eight hundred and twenty miles, was made enjoyably and leisurely in one of the comfortable sleeping-cars of the Swedish State railway, attached to an ordinary train. These north-going trains do not travel during the night, but stop the first night at Ånge and the second at Jörn,—an arrangement that renders sleeping in the cars agreeable. The journey, under these easy conditions, occupies fifty-six hours, and gives travellers an opportunity of seeing the country and verifying the geological map of Sweden for a considerable area. The country passed through is, as depicted, a general expanse covered with glacial and post-glacial deposits of peat-logs, clay, sand, gravel, and boulders, with an outcrop of granite or other crystalline archæan rock at very rare intervals. The resulting landscape is very pretty, if not very varied, and consists of nicely-wooded hills with intervening stretches of rolling, or flat, or marshy country amply provided with lakes, many picturesquely studded with fertile and wooded islands; moreover, the railway crosses (in some cases by notable bridges) nine considerable rivers, each adding a charming variant to the scenery, while the Arctic circle, crossed just before reaching Polcirkeln, a little more than forty-three miles south of Gellivare, lends a sentimental factor to the interest of the journey. The continuation of the line is projected from Gellivare to Victoriahavn on Ofoten Fiord in Norway,—a port that is open all the year round. This will serve the two great iron ore deposits at Kiirunavaara and Luossavaara, which, in fact, constitute the main cause of the extension.

The colossal deposits of iron ore at Gellivare, Kiirunavaara, and Luossavaara are situated in the province of Norrbotten, in Lapland, which, moreover, boasts of other deposits at Routivare, Svappavaara, Kilnavaara, Altavaara, and Kurravaara, shown on map (Fig. 1). But of all of these the first one alone is being exploited, it having railway communication with a port,—Luleå,—which the others have not, and therefore it will be the first to receive detailed attention.

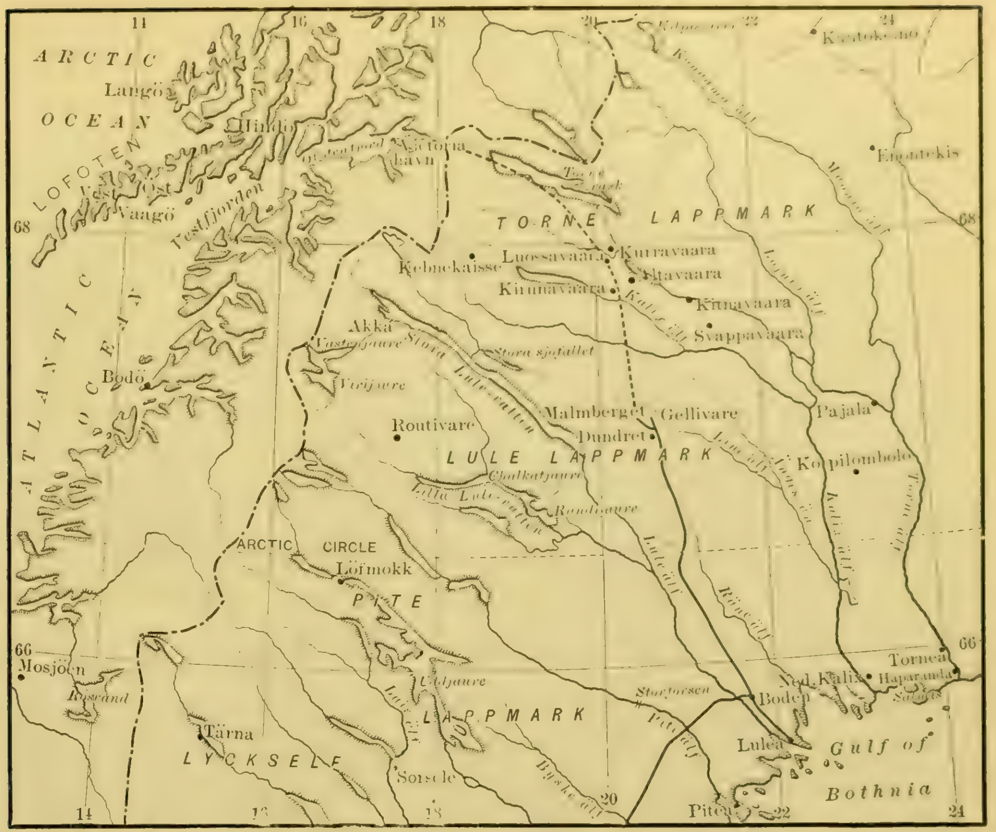


FIG. I. MAP OF THE IRON REGIONS OF SWEDEN.

These deposits are mostly characterised by the association of more or less apatite with the iron ore in which they occur, outcrops of archæan rocks as lenticular, bedlike masses, of which the horizontal sectional area has been ascertained to be as follows: Kiirunavaara-Luossavaara, 516,000 square yards; Routivare, 360,000 square yards; Gellivare, 240,000 square yards; Svappavaara, 45,600 square yards.

The horizontal sectional area of the deposits at Grängesberg is 108,000 square yards; at Norberg, 36,000 square yards; at Dannemora, 14,700 square yards; all others, of less magnitude. And the results at Gellivare show that the Norrbotten deposits are not going to take an inferior position when the yielding capacities are compared.

These deposits are by no means new discoveries, for they—at least, the Gellivare deposits—are referred to in an official report dated 1704. Moreover, projects for working them have been numerous; as far back as 1735 Lieutenant Tingvall obtained a concession for working the Gellivare deposits, and in 1735 received permission to erect a blast-furnace. He was a wise man in his generation, and turned his rights over to a company in 1742. But these and subsequent operations of the last century were of a very limited character, owing to difficulties of transport; anyway the deposits had become celebrated, and, by the end of the first quarter of this century, nearly all the ore-bearing ground had been taken up; but, in spite of this, the industry did not thrive. The work required to keep the concessions going was not done, and consequently the whole district came back into the hands of the crown. Since 1860, however, it has been in the keeping, first, of a Swedish-Norwegian syndicate; then of Anglo-Swedish companies, which did a considerable amount of useful work, especially toward the construction of the Gellivare-Luleå railway. The beneficial results of their operations are even now abundantly evident; but somehow the alien company was not regarded with great favor by the patriotic natives and their government, and various difficulties were encountered from this and other sources, that together rendered the efforts of the British companies unsuccessful, and the last of them came to an end in 1887, in which year Col. C. O. Bergman acquired the mines. The railway to Luleå was completed in the next year, and in 1890 the property was transferred to the present company, which was founded in that year by Consul G. E. Burns, who is still managing director and principal share-holder, and who has acquired for the company a large interest in the deposits further north and been largely instrumental in bringing to a satisfactory conclusion the negotiations connected with the railway extension to Ofoten. This extension, originally one of the objects of the British Company, has now received the approval of both the Swedish riksdag and the Norwegian storthing and, it is expected, will be complete in four years. In the meantime ore from Gellivare is transported to Luleå, a distance of some 130 miles, and, as the railway is under the control of the government, favorable rates are allowed to the Swedish company. Moreover, mining is now done systematically. The ores are carefully graded, and the quality of the graded ores is checked by analysis, so as to guarantee the quality of the exported material. It is not therefore surprising to find the annual export of ore very considerable in spite of the fact that the port of Luleå is frozen up for seven months in the year. The exports for the last six years and the present year are:

1892	139,194 tons.	1895	384,007 tons.
1893	260,754 “	1896	614,262 “
1894	525,728 “	1897	815,797 “
1898	804,732 tons.		

The present appearance of the town of Gellivare and of the country around it, looking northeast, may be gathered from Fig. 2. As will be seen, it is a modern, or modernised, place, with houses scattered here and there without any semblance of order. The river is the

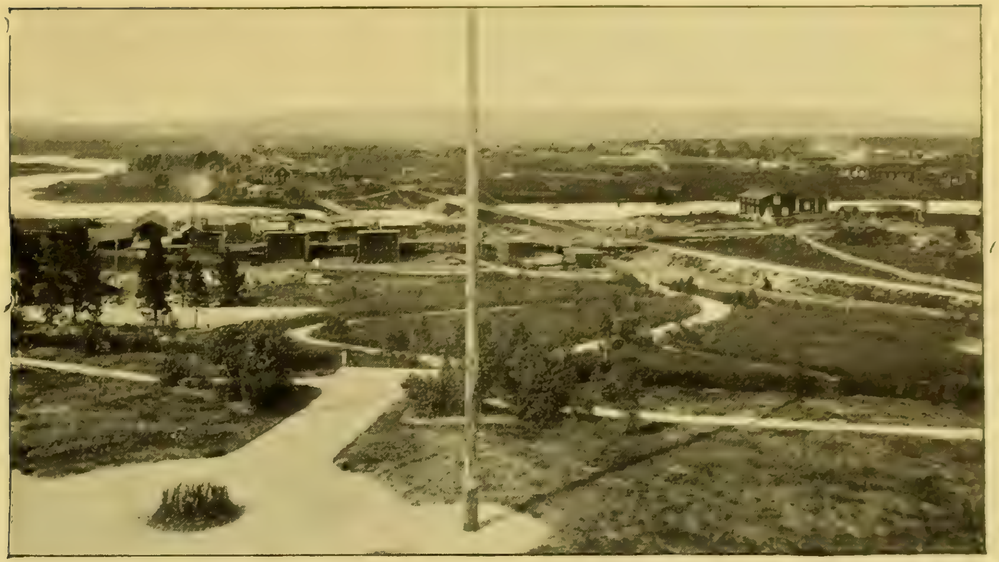


FIG. 2. GELLIVARE AND ITS SURROUNDINGS.

Vasara ; the heights in the distance are those of Malmberget, to which the railway runs ; it is some four miles distant, and is the home of the Gellivare iron ore deposits. A view of the hill and camp of Malmberget looking northward is given in Fig. 3. The tall chimney shaft on the left is that of the electric power station ; the building near the centre, above which the flag flies, is that in which the offices are situated ; just over the roof of that building is the great incline from Josefina and Upland mines. The house to the extreme right is that of the hospitable manager of the mines, Mr. Bosaeus, and is

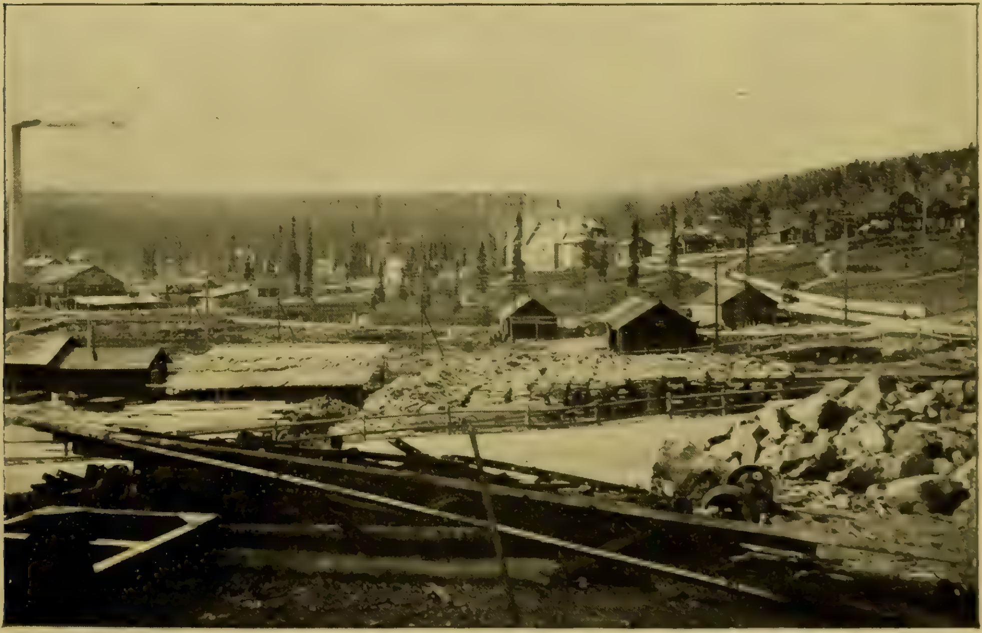
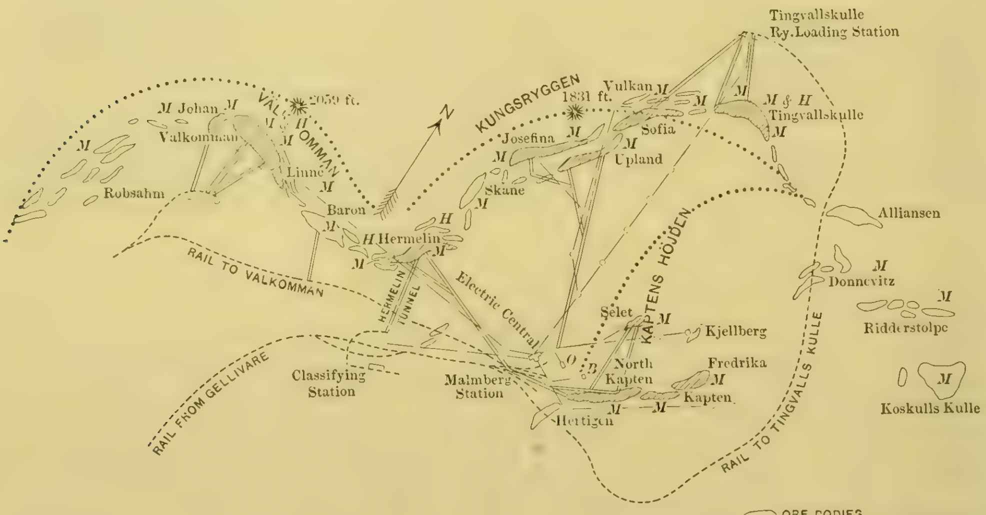


FIG. 3. MALMBERGET CAMP, LOOKING NORTH.

situated on the rising slope of Kaptenshöjden. The town of Malmberget, in appearance, calls to mind the mining camps of the western States, with the exception that the streets are not so regularly arranged and the stores not so imposing in character, for Malmberget's great stores resemble more an oriental bazaar. The saloon, too, is wanting, or is only a very dreary presentment of a western American saloon; in fact, there is a good deal of temperance in these northern districts. Malmberget has risen only with the mines, but has now six thousand inhabitants.



PLAN OF GELLIVARE IRON ORE DEPOSIT
FIG. 5.

The plan (Fig. 5) sets forth the orientation of some of the Gellivare iron ore deposits; they are very numerous, and are covered by almost one hundred and fifty claims. They form a broad broken chain of scattered deposits, of irregular form and magnitude, taking a serpentine course of about three miles in length in an outcrop of gneissic archæan rock, the axis of which is shown by the dotted line on Fig. 5, but which has a general trend northeast and southwest with a spur, Kaptenshöjden, to the eastward, separated by a valley. There are large deposits of ore both below the surface of the valley and cropping out on the hill. The main axes of the separate lenticular masses follow approximately the general curvature, so that some run north and south, some east and west, a few—"Vulkan," "Tingvalls Kulle," "Kapten," etc.—northeast and southwest, while others are even curved, such as "Hermalin," "Josefina," and "Sofia."

The highest point of Malmberget, which means "the mountain of ore," is at the western end, and is known as Välkommen. It is

2,059 feet above sea level and 670 feet above Malmberget station, and is continued eastward as a ridge, known as Kungsryggen as far as Tingvalls Kulle. The mountain is precipitous or steep on the north side, but forms a series of terraces on the south side, on which side all the deposits, except "Tingvalls Kulle" and the greater part of "Sofia," are situated. The ore bodies all dip to the south, but at different inclinations, varying from 40° to 80°. The deposits are mostly owned and mined by the Gellivare Company; but there are other proprietors, notably the Witkowitz Company, of Moravia, who own the most easterly deposits. In Fig. 5 the shaded areas indicate the deposits being worked; M indicates magnetite and H hæmatite, but I have not shown all the unworked deposits.

The mining is almost entirely open cast, and is similar throughout the whole neighbourhood; but both the methods of working and the character and aspect of the deposits will best be gathered from the series of photographs reproduced here, which represent various views in the chief mines and will be referred to in dealing with those mines.

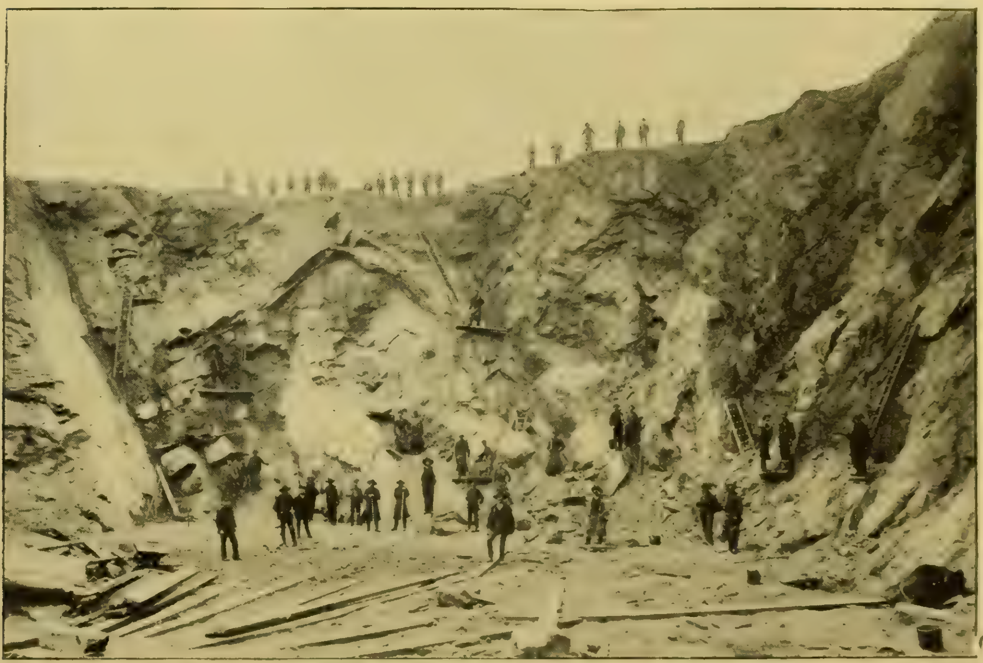


FIG. 6. WORKING FACE IN THE KING OSCAR MINE.

Starting from the northeastern extremity of Malmberget,—that is, at Tingvalls Kulle—one of the largest mines is encountered, known as King Oscar mine; Fig. 6 shows a working face in it. The deposit here consists mainly of magnetite, but there is also a considerable amount of hæmatite and apatite. At the outcrop it was 670 feet long and from 27 to 337 feet in width, and had a total area of 21,600 square yards. This is now represented by a vast excavation of the

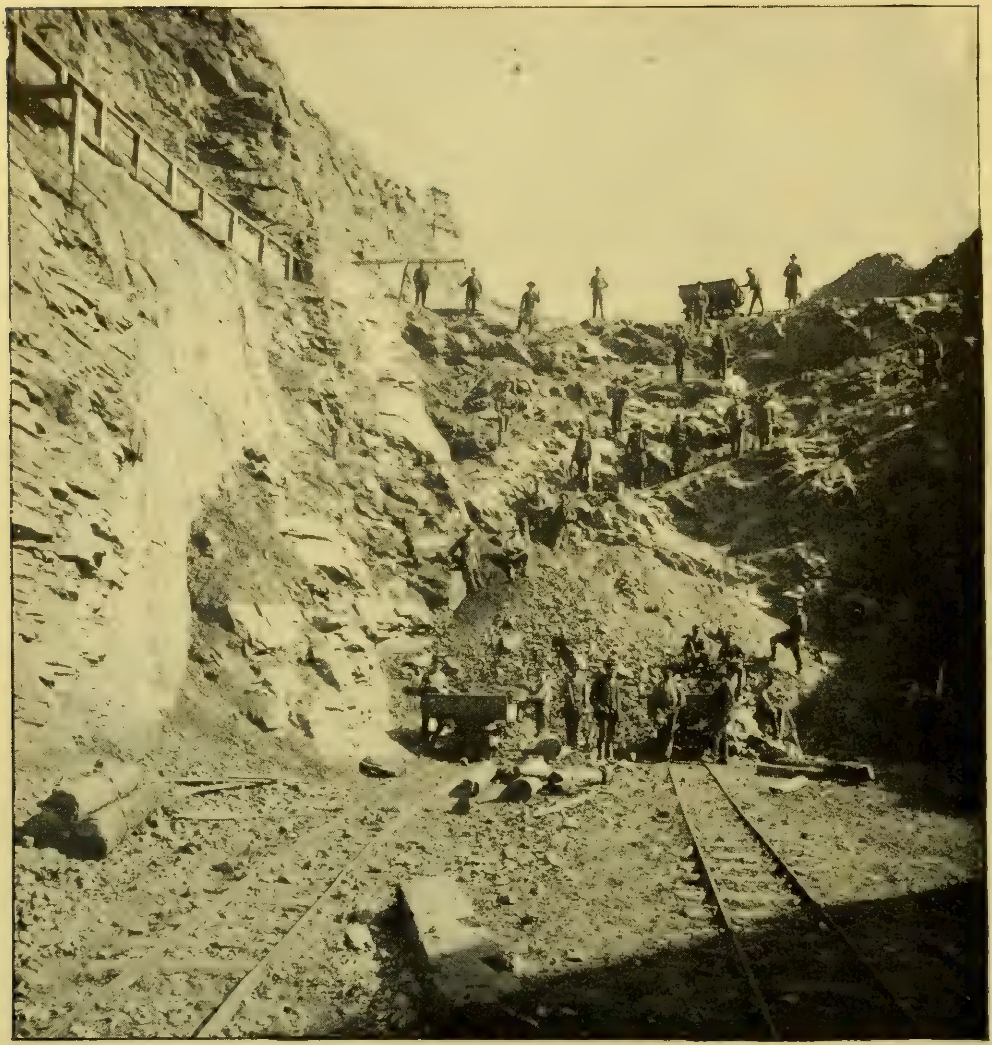


FIG. 7. WORKINGS IN THE HERTIGEN MINE.

dimensions indicated and from 70 to 120 feet deep, teeming with men and boys and resounding with the ring of the hammer and drill. Work was started at this mine in 1893, after the completion of the railway extension from Malmberget station to Tingvalls Kulle. This extension is 3½ miles long, and at its terminus is 370 feet below the top of Tingvalls Kulle; it is shown on the plan (Fig. 5) curving round to the east and northeast.

The method of working adopted here is the same as that employed, with slight modifications, throughout the Gellivare mines. The ore is mined open cast, and the broken ore is drawn out at the bottom of the working through a cutting, or through shorter or longer tunnels, as the case may be. In a very few instances ore is drawn up an incline out of workings not yet provided with other means of egress. The first level is generally made at a depth of from

60 to 70 feet, and, while the clearing-out of this section is going on, a shaft is sunk from the floor of the level in the ore, and a daylight tunnel is driven in from the hillside to meet this shaft at a depth of one hundred feet or so. The mass of ore intervening between the floor of the first level and the level of the tunnel is then worked out in two terraces, each fifty feet or so thick. The broken ore is then thrown down the shaft and charged in the tunnel into side-tipping trains of a capacity of 2½ to 3½ tons of ore, which are hauled out of the tunnel in trains by electric motors, either stationary or movable, and then transferred to self-acting inclines, which land them at the railway loading station ; the inclines are shown by the double lines in Fig. 5. It is noteworthy that the ore is picked and graded in the mines, any waste or gangue being stacked in heaps to be ready for stowing in future underground workings. The shaft is divided into compartments to accommodate the various grades of ore, which are also charged into different trains. The grading is in accordance with the percentage of phosphorus in the ore.

Grade A	Below 0.05 per cent.	
" B	From 0.05 to 0.1	"
" C	From 0.1 to to 0.8	"
" D	From 0.8 to 1.5	"
" E	Above 1.5	"

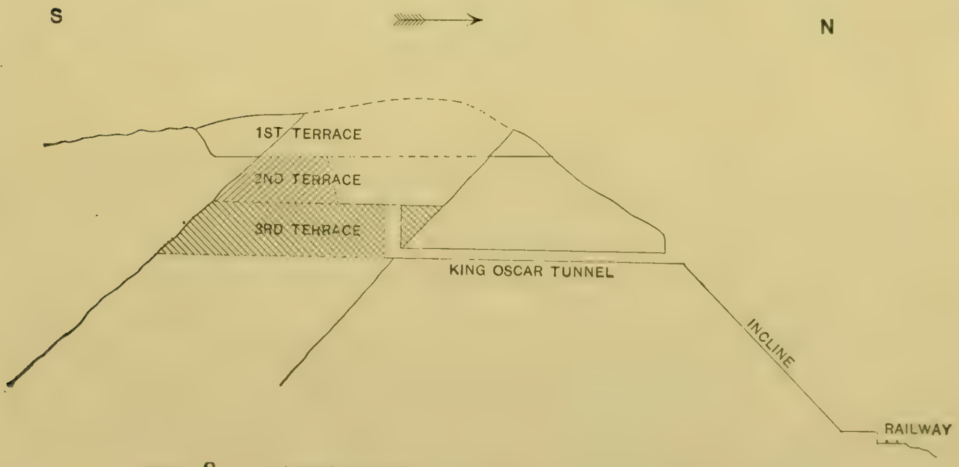


FIG. 8. DIAGRAMMATIC SECTION OF KING OSCAR MINE.

Fig. 8 is a diagrammatic sketch section of King Oscar mine, and illustrates the different stages of mining just alluded to. The space between the long inclined lines dipping towards the south represents the ore body ; the space marked first terrace shows the first stage of operations ; the second terrace, the second stage. It is in the bottom of this terrace that the view shown in Fig. 6 is taken. In it may be followed the mode of procedure pursued in bringing down the ore ;

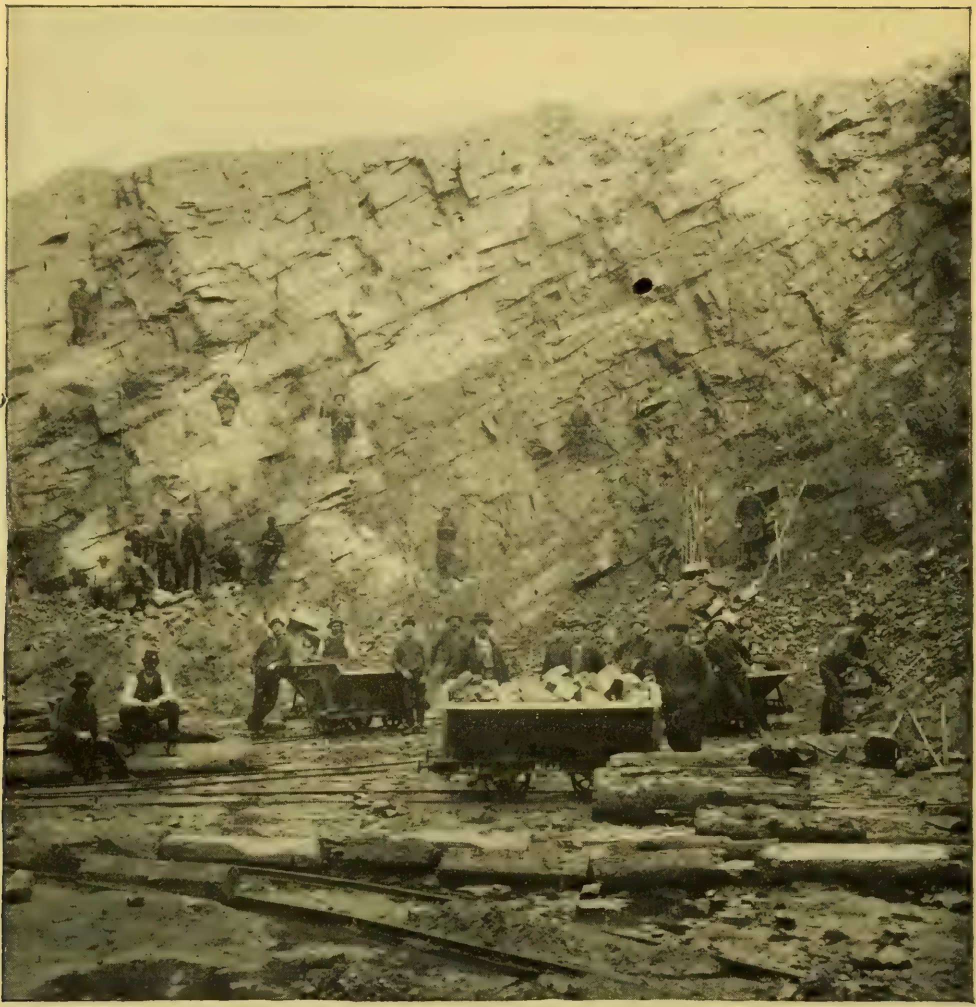


FIG. 9. IN THE SOFIA MINE.

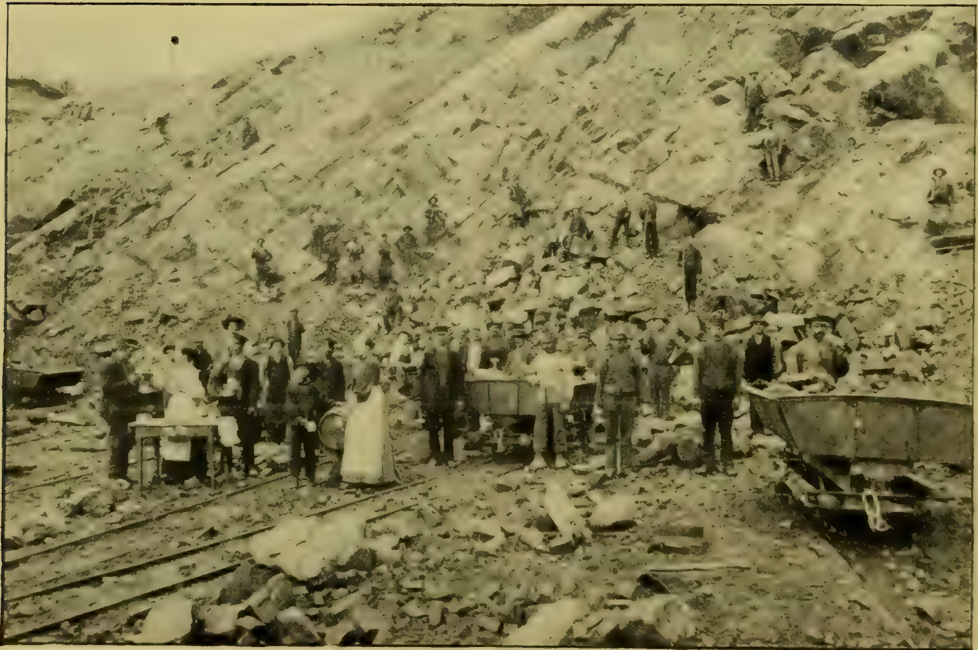


FIG. 10. VÄLKOMMEN MINE.

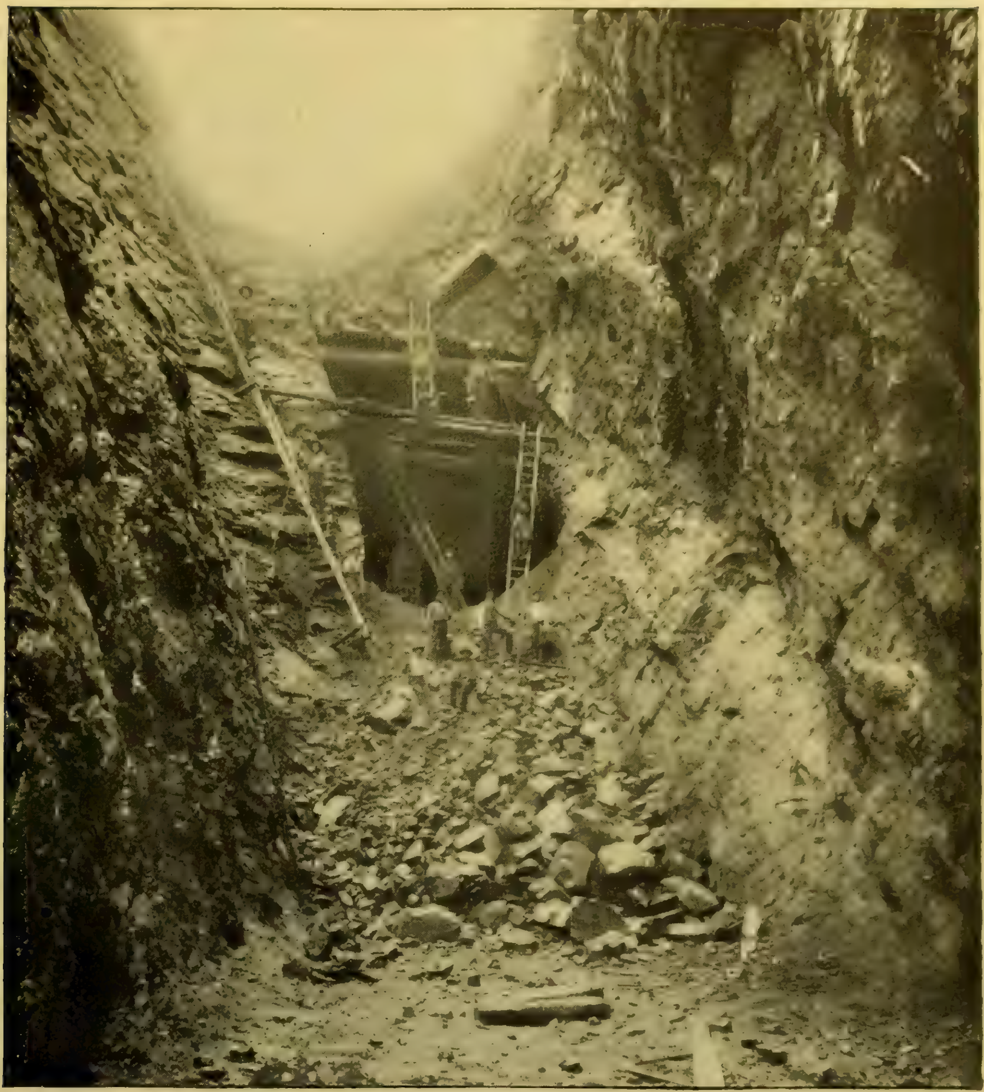


FIG. II. WORKINGS IN THE KAPTEN MINE.

stages erected at suitable positions are rendered accessible by ladders from above or below, and upon these the drillers work. The drilling is done by hand, either single-handed with a 5- or 6-pound hammer, or double-handed with 16-pound hammers, both of which may be seen in the hands of various miners in the view. Two men work together, and bore 8 to 10½ feet of 1½-inch holes, in this hard ore, in a shift of ten hours. The holes vary in depth, according to circumstances; dynamite is used for blasting; and blocks of ore that fall are shattered by means of dynamite in a chambered hole. Loading is carried on continuously, night and day, by men working in three shifts of eight hours each—electric light being employed when artificial light is required.

Reverting to Fig. 8, the trains of ore are hauled out of King

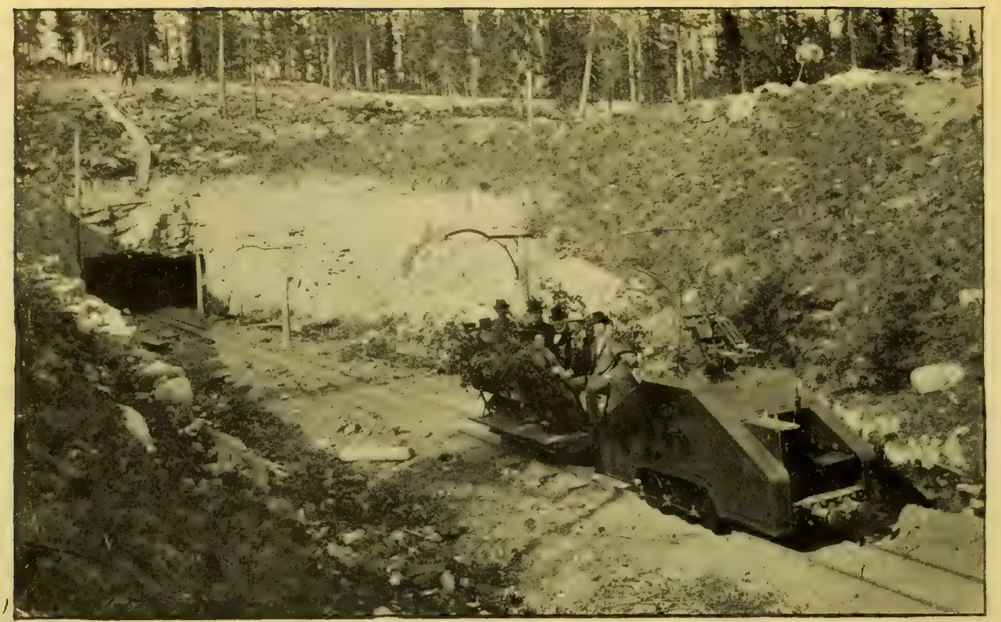


FIG. 12. ELECTRIC LOCOMOTIVE, HERMALIN MINE AND TUNNEL.

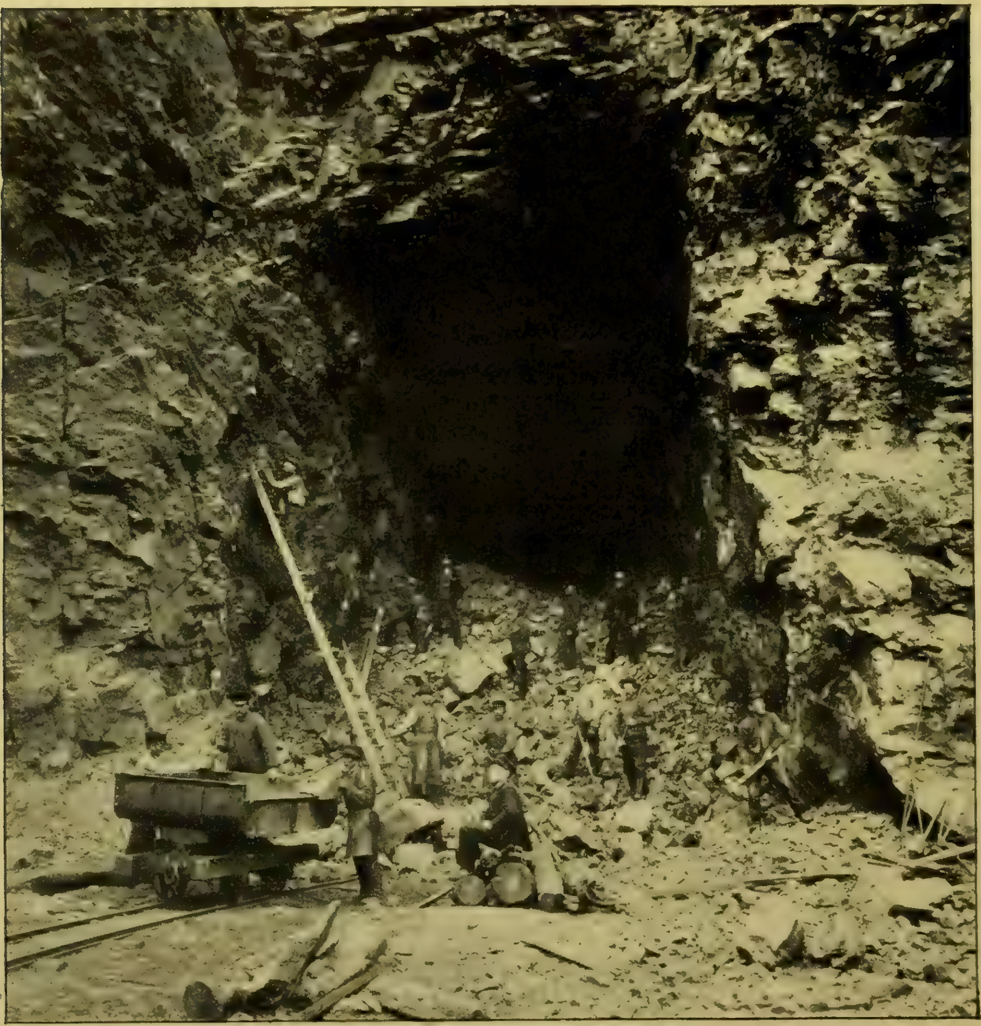


FIG. 13. WORKING FACE, SELET MINE.

Oscar tunnel by a stationary electric motor of 18 h. p. made by Siemens & Halske, and are dispatched down the incline in trains of three to Tingvalls Kulle loading station. It may here be noted that for future working of King Oscar mine a tunnel is to be driven in at this lower level. The present tunnel is 15 feet wide by 10 feet high. The next mine to King Oscar mine is called Sofia, and is the only other one on the north side of Malmberget. Fig. 9 is a view taken in this mine, and gives a good picture of the massive jointed wall of ore seen in this working. The Sofia deposit is 1,500 feet long and from 150 to 200 feet wide; it is situated across the ridge, Kungsryggen, and is worked in two mines, the upper fifty feet above the lower, from which two inclines take the ore to Tingvalls Kulle loading station eight hundred yards away. A new tunnel, a hundred feet below the lower mine, is being driven for future working. In Sofia mine was the only vein of pyrites seen by us throughout Malmberget, and that vein was small. It yields grades C, D, and E.

The next mine is Upland. It is worked in two terraces, and yields D and E ore, which, as indicated in Fig. 5, is run down inclines to a loading station at the main railway station. The same incline receives a branch from Josefina, the next mine, which is remarkable for its great length (1,000 feet), its comparative narrowness (65 feet), and its sinuous character. The next mine is the Hermalin, which is of particular interest on account of its position at about the middle of the chain of deposits. It has been selected as the site of a main tunnel 1,433 feet long, 18½ feet wide, and 10 feet high, which is adapted for three lines of rails. It is situated so that the trains from the mine are taken round a fine trestle work gauntree as shown in Fig. 5, to a sorting and screening floor, where three classes are made,—lumps, coarse, and fine, the former two being sorted and charged as grades A, B, C, D, E, into trains which are discharged from the floors direct into railway wagons alongside, whilst the fines fall into other trains that pass beneath the structure and are ultimately also tipped into wagons. This arrangement is, and will be, of use whenever the sorting in the mine becomes impracticable. The Hermalin tunnel is to be used for working the Hermalin deposit, which was encountered when the tunnel had been driven a distance of 1,400 feet. The ore is 100 feet thick at the intersection. This tunnel is being continued in two branches, 13⅓ feet wide and 10 feet high, one to the westward to tap the Baron and ultimately the "Välkommen" deposits, the other to the eastward to reach the Skåne and ultimately the Tingvalls Kulle deposits; of course intermediate blocks of ore will be encountered in each case, and will not be neglected. The haulage in Hermalin tunnel is by electric locomotive, as shown in Fig. 12, the load being a train of six trains, each holding 3½ tons of ore. The tunnel is lighted by electricity. The illustration in Fig. 10 is from the Välkommen mine. The overburden, in all cases, is glacial drift. It varies in thickness, and is even absent in many instances. The figure shows the mine in a later stage of development, and affords an opportunity of studying the people and the tip trains. Hæmatite as well as magnetite is met with in Välkommen as in King Oscar mine. In all three—Välkommen, Johan, and Linné—the ore is phosphatic. It is delivered down inclines to the branch railway from Malmberget stations. The first two are worked from the same tunnel, which is 830 feet long, but for future working a tunnel is to be driven in at the level of the railway. The deposits further west are of less importance.

Therefore I shall pass to the Kaptenshöjden. The deposits there, although mentioned last, are neither the least in magnitude or the least in importance. As a matter of fact, being near the station and low level, they were the first to be worked in the four mines—Hertigen, Kapten, Fredrika, and Selet. Their positions are shown in Fig. 5. Figs. 7, 11, and 13 give an idea of the workings in this part of the district. The views are, respectively, from the following mines—Hertigen, Kapten, and Selet. The ore is mostly free from phosphorus, and in some cases is, and in others will shortly be, worked out to the level of the railway; consequently the ore has to be hoisted, and three shafts are being sunk in the hanging wall. They are to be taken to a depth of 28 fathoms below the level of the railway, and in the spring underground mining operations will be commenced.

It now remains to add that the power required is supplied from an electrical station equipped with three 120-h.p. and one 360-h.p. compound condensing engines. The small engines each work two continuous current dynamos, series wound, of 250 volts and 180 amperes, while the large engine works a similar dynamo of 500 volts and 460 amperes duty. The power is utilised in 130 arc lamps, 500 incandescent lamps, 16 motors, one 30-h.p. and one 15-h.p. locomotive, and for heating the office with electric stoves. The motors are applied in the following operations: four, 2 h.p., pumping and ventilating; two, 5-h.p., crushing; seven, 18 h.p., hoisting; two, 15 h.p., in the workshops; one, 30 h.p., haulage.

The number of men employed in the mines is about 1,500 all the year round, with an additional 500 in summer, when there is a great amount of incidental and special work to be got through. Up to the present the majority of the work-people are not housed well, but the company, in course of time, will remedy that. Very little good vegetation can be grown in the district, and even the cows acquired to supply milk during summer have to be slaughtered before winter, as they cannot withstand the severity of the season. So fresh provisions are scarce. But, in spite of the high latitude,—nearly 68°,—the temperature seldom falls below —20° Centigrade. Moreover, owing to the hills around, the place is protected from winds; and snow and frost do not interfere much with the working of these mines.

The ore wagons from all the mines gravitate ultimately to Malmberget station, where the trains are made up and despatched to Luleå. On arrival at that port control assays are made, and the ores are either stored or shipped in their particular grades. Grade E and the fine stuff are, however, heated, in order to separate the magnetite and hæmatite from the apatite. The first is separated by means of magnetic separators, while the other two are separated in an ordinary washing mill, furnished with jigs, riddles, and shaking tables. The fine iron ore is at present not a very profitable product, and many schemes have been tried to render it more suitable for melting purposes. The separated and finely-divided apatite, along with the associated quartz and felspar, is converted into a fertiliser by Wiborgh's process of drying and then grinding and mixing with salt cake, and fritting the mixture at about 1,000°. The resulting product, being finely pulverised, comes on the market as Wiborgh phosphate, and is a valuable asset. The mill treats two hundred tons of ore a day, and the yield of this phosphate is 1 to $1\frac{1}{5}$ per cent. of the weight of the ore. It is worth 75 krone a ton.

The arrangements at Luleå, or, rather, near it, are very interesting and good, for, in addition to the mill, there is a fine electrical plant, great storage places, and remarkable shipping staiths, capable of disposing of 800,000 tons in the available five months that the port is open.

One of the many delightful reminiscences of the visit to the far north of Europe was the charming view from the highest staging of the separating mill,—the fine natural harbour of Luleå, with a fleet of great vessels within loading or waiting for loading or sailing away, then the town of Luleå, and, beyond the peninsula upon which the town is situated, the head waters of the gulf of Bothnia stretching to the horizon. The whole forms a charming picture, illuminated by the early autumn sun.

THE COMMERCIAL ASPECTS OF ELECTRIC LIGHTING IN GREAT BRITAIN.

By Robert Hammond.

TWENTY years ago no works existed in the United Kingdom for the generation and distribution of electrical energy. They first came into operation for the purpose of supplying energy to arc lamps used for street illumination, the energy being, with few exceptions, distributed by means of overhead wires, the sectional areas of which were kept within practicable bounds by limiting the current to 10 amperes and by running forty or fifty lamps in series with an electromotive force of 2,000 to 2,500 volts. When incandescent lamps were invented, the lower voltages required to feed them necessitated distributors of vastly-increased proportions, and it became obvious that no extensive scheme of distribution of electrical energy could be carried out, except by means of mains laid underground.

In various parts of the country contractors and promoters entered into negotiations with vestries, municipalities, commissioners, etc., hereinafter—as the lawyers say—called local authorities, in order to secure the right or franchise of using the roads and sidewalks of the respective cities and towns for the purpose of laying such mains. Two towns—Hastings and Eastbourne—ceded such rights, the writer in both cases being the fortunate licensee. Others were prepared to follow suit, but one of the shrewdest town clerks in the kingdom, Mr. Samuel, now Sir Samuel, Johnson, expressed the opinion that, as the actual ownership of the roads was not vested in the local authorities, their rights of user of the same were strictly confined by the various acts of parliament relating to the same. They could break up the roads for the purpose of doing work on the sewers or of providing a system of street illumination, or, if they were the gas authority, of inspecting, repairing, or laying gas mains; and they could also operate at their sweet will in the direction of repairs to the road itself, or re-metalling. Beyond these powers they had none, and consequently could pass none to others. Any agreements made by them, therefore, permitting the licensees to lay down mains for the purpose of distributing electric energy were *ultra vires*, and could be blocked by any citizen who chose to take action. Sir Samuel's opinion was almost unanimously accepted as sound, and in the session of 1882 a batch of bills were promoted, the object of which was to endow local authorities with the power to enter into agreements in respect of the laying of underground mains and the supply of electrical energy to private persons within their area. The government then drafted a bill, and it, with the eight promoted privately, was referred to a select committee, the result being the passage by parliament of a general act entitled: "Electric Lighting Act 1882 [45 & 46 Vict. CH 56]. An Act to Facilitate and Regulate the Supply of Electricity for lighting and Other Purposes in Great Britain and Ireland [18th August, 1882]."

During the investigations of the committee a large amount of evidence was tendered on the importance of preventing the supply of electrical energy from becoming so onerous for the community as the gas monopoly had become. It was pointed out that in very many cases the local authorities had been compelled to purchase gas undertakings at figures far in excess of the capitals expended thereon and arrived at by giving the gas companies the benefits of long periods of prospective profits. The committee was determined that, if the new industry became a profitable one, the profits should, as far as possible, be enjoyed by the community at large, instead of being distributed among the capitalist class. The Right Honorable Joseph Chamberlain, then president of the board of trade, had demonstrated in his adopted town of Birmingham how excellently the administration of the water and gas service could be conducted by the municipality. He supported the committee in its determination to afford every opportunity to the local authorities to lay down electricity works.

Accordingly the act empowered local authorities to expend their funds in carrying out electric-lighting undertakings, and, in cases where the local authorities desired to delay embarking in the business, and powers were granted to companies, the option of purchase of the undertaking was secured to the local authority on terms very stringent to the companies. Under the act of 1882 the options of purchase were exercisable after the expiration of twenty-one years, and of every subsequent seven years, these periods being afterwards extended, by the act of 1888, to forty-two years and ten years respectively.

In order, however, to provide that the local authority should work the undertaking for the benefit of the community at large, it was enacted that:

"All moneys from time to time received by the undertakers in respect of the undertaking, except (*a*) borrowed money, (*b*) money arising from the disposal of lands acquired for the purposes of this order, and (*c*) money not of the nature of rent received by them in respect of any transfer under the provisions of this order, shall be applied by them as follows:

(1.) In payment of the working and establishment expenses and cost of maintenance of the undertaking . . . .

(2.) In payment of the interest or dividend on any mortgages, stock, or other securities granted and issued by the undertakers . . . .

(3.) In providing any instalments or sinking fund required to be provided . . . .

(4.) In payment of all other expenses of executing this order, not being expenses properly chargeable to capital.

(5.) In providing a reserve fund, ...

"The undertakers shall carry the net surplus remaining in any year, and the annual proceeds of the reserve fund when amounting to the prescribed limit, to the credit of the local rate as defined by the principal act, or at their option shall apply such surplus, or some part thereof, to the improvement of the district for which they are the local authority, or in reduction of the capital moneys borrowed for electricity purposes.

"Provided always that, if the surplus in any year exceed five pounds per centum per annum upon the aggregate capital expenditure on the undertaking, the undertakers shall make such a rateable reduction in the charge for the supply of energy as in their judgment will reduce the surplus to the said maximum rate of profit; but this proviso shall only apply to so much of the undertaking as shall for the time being remain in the hands of the undertakers."

For the purpose of securing the proper performance of this condition, it was further enacted that:

"The undertakers shall, on or before the 25th day of March in every year, fill up an annual statement of accounts of the undertaking, made up to the 31st day of December then next preceding; and such statement shall be in such form, and shall contain such particulars, and shall be published in such a manner, as may from time to time be prescribed in that behalf by the board of trade.

"The undertakers shall keep copies of such annual statement at their office, and sell the same to any applicant at a price not exceeding one shilling a copy."

The term "undertakers," which appears above, has been interpreted by some wag to mean those who hold the privilege of burying the cables, but is defined in the Act, Clause 2, as applying to "every local authority, company, or person . . . authorised to supply electricity (more properly, electrical energy) within any area."

Since the general community is not interested in the way in which companies deal with their profits, it may appear curious that the provision with regard to publication of "accounts" should be made to apply to them as well as to local authorities.

On reference, however, to the "form" prescribed by the board of trade, it will be seen that the undertakers have not only to state the amount of the revenue and the working expenses of the undertakings, but to analyse the expenditure under numerous headings, which may generally be summarised as under:

(1) Coals or other fuel; (2) oil, waste, water, and stores; (3) wages on generation and distribution; (4) repairs and maintenance; (5) rents, rates, and taxes; (6) management,—*i. e.*, salaries, stationery, and printing, general establishment charges, law expenses, insurance, etc.

There is also appended a form from which, if it be faithfully and fully filled in, it is possible with ease to arrive at the cost of, as well as the average revenue arising from, the "units sold," to discover the load-factor, and to determine the percentage of "quantity not accounted for."

In the case of companies the returns have to be audited by an auditor appointed by the board of trade, and the writer can certify from experience that this audit is most searching.

This carefully-prepared and audited annual statement on the part of the companies was intended by the legislature to secure to the local authority covering the area of supply the opportunity of observing whether the profits arising from the undertaking were of sufficient importance to warrant the local authority in exercising its option of purchase at the end of the statutory period, or at any earlier period that might have been by agreement inserted in the provisional order (confirmed by act of parliament) under which the company was operating.

To give an instance of the operation of the clause:

The city of Leeds (population 402,449) owns its gas works, and supplies gas at two shillings per one thousand cubic feet, and for years the idea of the electric light being able to compete at this figure was ridiculed. In 1890 a committee of the corporation recommended that a provisional order should be applied for, in order, at all events, to prevent the inroads of a company. A strong minority of the members of the town council, however, held the view that, with the corporation gas at so low a price, there was no chance of outside capital being forthcoming to start a competition on the part of electric light, and no possibility of the commercial success of electricity supply works, if any capitalists were found imprudent enough to start them. Deciding, therefore, not to erect their own electricity works, though only by a bare majority of one in the town council, the corporation was logically compelled to sanction a provisional order in favor of a company, which was at once formed by local capitalists under the conviction that there was a profitable field for electricity, however low the price of gas.

It fell to the lot of the writer, in his province of consulting engineer, to lay down the works, which were opened in May, 1893, and have shown the following highly-encouraging results:

FINANCIAL RESULTS OF ELECTRICITY WORKS IN COMPETITION WITH GAS AT 2S. PER THOUSAND FEET.

Year.	Capital invested at end of year.	Profit on Working.	Percentage on Capital employed during year.
1894	£ 64,118	£ 3,709	6.98%
1895	76,526	6,780	9.64%
1896	105,377	10,475	11.51%
1897	161,000	13,193	9.90%
Total profit for first 4 years		£34,157	

In this case the provisional order agreed between the company and the local authority—*i. e.*, the Leeds municipal corporation—contained a clause giving to the local authority the option of purchase

(*a*) at any time prior to July, 1901;

(*b*) by the issue to the company of such an amount of Leeds muncipal corporation stock as will produce, by the interest or dividends thereon, an annuity of five per cent. upon the sum expended by the company upon its undertaking and chargeable to capital account.

The opportunity afforded to the local authority by the clause in the act with regard to the filing of audited accounts with the board of trade enabled it to judge of the advisability of securing the undertaking for the benefit of the city, with the result that the examination of the accounts convinced the local authority of such advisability; and early in 1898 it made an application for permission to purchase, to the government department,—*i. e.* the local government board, without whose consent no local authority in the United Kingdom can embark upon expenditure of capital.

The application was successful, and the local authority is proceeding to issue at par that amount of 5 per cent. stock which will cover the capital expenditure of the company to September 30, 1898.

It may be of interest to capitalists in the United States to know that Leeds 5 per cent. stock is worth about 100 per cent. premium in the money market, so that the fortunate shareholders in the Leeds company have the gratification of receiving a bonus of 100 per cent. upon their original investment.

This digression will have served to illustrate the position and status of the industry. The writer desires to emphasize the fact that the annual publication of carefully-audited accounts is obligatory on all who hold statutory obligations to supply electrical energy in the United Kingdom.

The extent to which the data have been growing may be seen by the following table :

Year.	Number of works operating or applying for powers.	Year.	Number of works operating or applying for powers.
1882	2	1891	31
1883	3	1892	39
1884	3	1893	62
1885	4	1894	81
1886	4	1895	93
1887	6	1896	112
1888	7	1897	121
1889	14	1898	132
1890	17		

The board of trade has made no publication of the returns filed with it in accordance with Section 9 of the act, and the only course open to the inquirer is to apply to the various undertakers for copies of the same.

Those who conduct industrial enterprises for profit have a strong inducement to conceal their costs of working, for, if faithfully set forth, they might provoke either competition or commiseration. Here, however, we have an industry—possibly the only one in the world—which is compelled by law to afford the minutest information as to its financial operations.

It is, unfortunately, out of my power to include the costs of production in works established solely for the supply of electrical energy to tramways, these works being under no statutory obligation to file such returns. The figures tabulated by me refer to those undertakings that are operating under the electric-lighting acts, 1882–1888, having, of course, electric lighting for their main object, and being assisted only to a very slight extent by a demand for electrical energy for other purposes than lighting ; though in the provisional orders under which they are operating it is made clear that they are constituted in their districts the suppliers of electrical energy for all purposes that may be demanded.

It would take up too much space to set out the board of trade form in its entirety. I will content myself by detailing the items which make up one of the eight subdivisions :

Dr. *REVENUE ACCOUNT.* Cr.

No. III. For the Year ending 31st December, 18

A. *To generation of Electricity*

1. To coals or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works.
2. To oil, waste, water, and stores.
3. To wages at generating stations.
4. To repairs and maintenance, as follows:
   Buildings,
   Engines, boilers,
   Dynamos, exciters, transformers, motors, etc.,
   Other machinery, instruments and tools,
   Accumulators and accessories.
   Less received for old material.
5. To other items (to be specified).

B. *To Distribution of Electricity.*

1. To wages and other remuneration to linesmen, fitters, laborers.
2. To repairs, maintenance, and renewals of mains of all classes, including materials and laying the same.
   Less amounts refunded.
3. To repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, together with cost of materials and lamps sold, as *per contra.*
4. To repairs, maintenance, and renewals of apparatus at distributing stations.

C. *To Public Lamps.*

1. To attending and repairs.
2. To renewals of lamps.

D. *To Royalties, etc.*

To royalties, etc., payable for use of patents or patent processes.

E. *To Rents, Rates, and Taxes.*

1. To rents payable.
2. To rates and taxes.

F. *To Management Expenses.*

1. To salaries,—*viz.*,
   Engineers' Department,
   Accountant and Clerical Staff.
2. To salaries or commissions of collectors.
3. To stationery and printing.
4. To general establishment charges.

G *To Law and Preliminary Charges.*

1. To law expenses.

H. *To Special Charges.*

1. To insurance, etc.
2. To expenses for certification of meters.

Total expenditure

Amount carried to net revenue account...

Balance carried to next account to provide for bad debts..

1. By balance from last account.
   Less bad debts written off.
2. By sale of current per meter at per B. T. U.
3. By sale under contracts.
4. By public lighting.
5. By rental of meters and other apparatus on consumers' premises.
6. By sale and repairs of lamps, arc or incandescent.
   By sale and repairs of other apparatus.
7. By royalties, licenses, etc.
8. By rents receivable.
9. By fees for inspection of maps.
10. By other items (to be specified).

In order to make a fair comparison possible between the results achieved by the various works, the writer has extracted and analysed the following costs *per unit sold* of—

I. Coals or other fuel;
II. Oil, waste, water, and stores;
III. Wages (on generation and distribution);
IV. Repairs and maintenance;
V. Total of I, II, III, IV,—*i. e.*, Works Costs;
VI. Rent, rates, and taxes;
VII. Management,—*i. e.*, salaries, stationery, and printing, general establishment charges, law expenses, insurance, etc.
VIII. Total costs.

With regard to the "unit sold," I may explain that the consumers may demand a supply as registered by meter fixed on their premises, and the "unit sold" is the arbitrary measure fixed upon as the basis of the selling price by the board of trade, the unit equalling a kilowatt-hour,

The maximum price imposed by the board of trade in the majority of the provisional orders is 8d. per unit, but the price actually charged varies in various places, the lowest prices charged at the present time being: For private lighting, 3d. (6 cents) per unit; for public lighting, 1¼d. (2½ cents) per unit; for power to factories, 1½d. (3 cents) per unit; for tramway traction, 1d. (2 cents) per unit.

In some places under the operation of the demand indicator system, the long-hour consumers get their electrical energy for considerably below 4d. per unit, the average for all services in Brighton, for instance, in 1897, being 3.77d. and in Edinburgh, 3.5d. per unit.

Obviously, in the scope of a magazine article it is necessary to limit the review of costs to those of a limited number of works, and a selection is made of those of

GROUP I.

Works situated in London.	*Pressure.*	*Outside London.*	
Kensington	Low	Edinburgh	Low & High
Saint James	Low	Leeds	High
Westminster	Low	Manchester	Low

GROUP II.

All outside London:

Bradford	Low Pressure.
Brighton	Low & High Pressure.
Bristol	High Pressure.
Glasgow	Low Pressure.
Portsmouth	High Pressure.

The division of the groups is purely arbitrary, and made for convenience.

I set out in the table the costs of working at these places, as shown by the latest returns.

TABLE OF SOME COMPARATIVE LOW COSTS PER UNIT SOLD.

	BRADFORD 1897 Units sold 993,588	BRIGHTON 1897 Units sold 1,992,527	BRISTOL 1897-8 Units sold 910,888	EDINBURGH 1897-8 Units sold 2,894,437	GLASGOW 1897-8 Units sold 2,114,036	LEEDS 1897 Units sold 833,280	MANCHESTER 1897-8 Units sold 3,434,850	PORTSMOUTH 1897-8 Units sold 981,273	LONDON		
									KENSINGTON 1897 Units sold 1,898,362	ST. JAMES 1897 Units sold 3,028,242	WESTMINSTER 1897. Units sold 4,355,781
	d	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*
Fuel	.38	.62	.88	.35	.45	.25	.45	64	.69	.51	.63
Oil, Waste, Water, and Stores	.10	.08	.07	.05	.06	.05	.16	.24	.11	.07	09
Wages.......	.34	.35	.49	.18	.26	.35	.24	.23	.29	.29	.34
Repairs and Maintenance	.17	.28	.16	.19	.49	.13	.26	.38	.42	.40	.23
Works Costs.........	.99	1.33	1.60	.77	1.26	.78	1.11	1.49	1.51	1.27	1.29
Rent, rates,and taxes	.28	.13	.27	.15	.30	.08	.17	.10	.41	.21	.22
Management Exps...	.52	.30	.46	.28	.36	.64	.34	.29	.69	.71	.68
Total Costs	1.79	1.76	2.33	1.20	1.92	1.50	1.62	1.88	2 61	2.19	2.19

From the above it will be seen that we have succeeded in the United Kingdom, in some dozen works, in bringing down the total costs of generation and distribution of electrical energy to less than two pence per unit.

EDITORIAL COMMENT

THE Nicaragua Canal is being actively agitated in congress, and indications point, all too strongly, toward the assumption by the government of the Maritime Canal Company's "pig in a poke"—the transfer of very definite cash for very dubious rights to carry on a work of wholly uncertain expense and difficulty. There is a suspicious fever to rush the matter, under cover of the excitement springing from the war, without waiting for the report of the commission organized and sent out expressly to obtain definite information as to the engineering aspects of the work.

Granting everything that can be claimed by the advocates of an isthmian canal, one waterway is ample—and that seems assured by the Panama enterprise. Its engineering features are apparently much more favorable, and at least are thoroughly known. It seems certain to be pushed through to completion and opened impartially to the commerce of the world without any care or expense to us. Why should we spend millions buying the trouble of an undertaking which is indefinite in difficulty, doubtful in value, absolutely undesirable as a national possession, and inexcusable as a duplicate of any corresponding waterway?

England, who, as the great commerce carrier of the world, has most to gain from any betterment of carrying routes, displays her larger wisdom by her apparent disposition to ignore the Clayton-Bulwer treaty, and to allow us to build the canal alone, if we will. The gain to commerce, and to the total wealth of the world, by the building of the canal will doubtless be enormous. It is questionable whether the actual builders will receive proportionate returns. England is quite willing to let her neighbor build the highway, assured that she may travel in it freely. She is content with the substance; we seem anxious to waste our substance on the sentiment.

THE most striking feature in industrial circles is the cumulative evidence of a great and accelerating export movement. General statistical figures are impressive enough, but individual instances bring home even a more vivid appreciation. A machine-tool builder in one of the principal manufacturing cities of the central States said recently, in conversation, that 90 per cent. of his product was now going abroad. His shop had been running day and night for months. Another tool-maker in the same city was taking all orders subject to a year's delay in delivery. The same story comes from every quarter. Ship plates are going to Belfast and to the Clyde; steel rails to Africa, India, and Europe; fire-proof structural materials to Ireland; machine-tools everywhere.

The development offers enormous possibilities for advantage to American manufacturers, but seems to be hampered by two unfavorable influences. The first is a too-general inertia—an unreadiness to meet the foreign demand halfway, study its preferences, and adapt details to its requirements or customs; the second is the short-sighted policy of secretiveness dominating many of the concerns which have made some entry into foreign trade, and which seem to fear that anyone else's participation means their own loss.

The policy which will best serve every individual is one of strong personal effort and study, and of broad coöperation and participation with every other interest concerned in export business. To a campaign of this character, the opportunities are limitless.

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CLOSE on the announcement of the new tobacco and pottery trusts comes a report of another consolidation of manufacturing interests,—this time closely related to the engineer. Electric elevators furnish the province for the new "combine" which is said to have been incorporated—or to be upon the point of incorporation—with a capitalization of $11,000,000.

Many strong arguments have been advanced to justify the trust. The elimination of unnecessary duplication, the removal of ruinous competition, the ability to introduce effective economies in large-scale manufacturing, the advantages gained by a comprehensive view of supply and demand—all these are arguments of weight. In one notable instance, vast profit to the promoters has proved consistent with great gain to the consumers; but the conditions were peculiar, especially in the foundation of the business upon natural supplies of limited distribution.

If the movement is in accord with natural evolution, it will thrive; otherwise it will have its day and disappear—like monopolies by royal patent, the policy of protection, and other attempts to direct industry into artificial courses.

It is hard to see how it differs from the shortsighted efforts of the labor-unions to check individuality, and to force the march of progress into the step of the chain-gang. Progress springs from the individual; the average is raised by emulation of the leader, and the leader is stimulated by the opportunity for great personal reward. For a time, the artificial order may seem to prevail. Eventually, it will find its limitations in the decadence due to mediocrity within its bounds, and the impossibility of stifling the constantly-springing individual competition without.

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THE fuller examination of the fire-damaged Home Life Insurance building, in New York, is relied upon to settle many extremely interesting questions concerning the steel-skeleton construction.

At present writing it is early to dogmatize, but some facts seem clear. One is that open spaces and unprotected glass windows are not fire-resisting; this hardly needed demonstration—but yet, in spite of regulations, the building was not provided with the prescribed iron shutters. If it had been, it would, in all probability, have been practically uninjured to-day.

A second is that the prediction of Chief Bonner is completely fulfilled. When the "skyscraper" takes fire on top, even the powerful department whose apparatus and organization were illustrated in these pages last February can do nothing but "let her burn." The outcome seems to be a revival of the agitation for a building law limiting the extreme height of these structures. The effect of the demonstration upon tenants and insurers, and, through them, upon investors, should be more effective than any legislation.

On the whole, the building seems to have resisted the external fire remarkably well; but, once the fire had gained access, it burned fiercely—with an intensity sufficient to melt brass fixtures, wreck partitions, destroy the stone curtain wall, and possibly so damage the steel structure itself as to demand the demolition and rebuilding of some portion, at least, of the framing. It seems impossible to resist the conclusion that equal disaster could follow a fire originating entirely within the structure, in any story above the reach of the streams from the engines.

It is safe to predict that rebuilding of the steel framing, if necessary, will prove extremely troublesome and expensive—so much so as to startle the insurance companies who have been writing these risks at absurdly low rates.

* * *

THE world will probably see, in Porto Rico, the opening of a new territory that is old, and the most perfected resources of engineering applied to pioneering work. The seizure of the island by the United States during the recent war with Spain will result in the exploitation of one of the richest regions in the world, and it is altogether likely that it will be done in a most original and characteristic fashion.

The island is almost rectangular in shape, 95 miles long and 35 miles wide. There is the usual strip of flat coast lands extending throughout the circumference, while the interior is a mountainous plateau having elevations of about 3,800 feet above the sea level. Almost the whole area is under cultivation, sugar cane and tobacco growing luxuriantly on the lowlands, while coffee and tobacco, as well as many fruits and vegetables, are cultivated on the central plateau. There is one road, the magnificent Spanish military road across the island from San Juan on the north to Ponce on the south coast, and in all about 35 miles of railway, in three disconnected sections. The population is about one million, and there are several large and well built towns, those in the interior being generally at elevations of from 1,000 to 2,000 feet above sea. The climate is genial and there is no yellow fever, the interior being reported as extremely salubrious. In many ways the island bears a strong resemblance to Ceylon.

While there is already much wealth in Porto Rico, two causes have contributed to hamper the development of its very great resources—the total absence of means of transportation and the almost incredible dishonesty of the Spanish régime, now happily superseded. In addition to these considerable obstacles there has long existed an organized system of brigandage, taking toll of all merchandise going into or out of the interior. The percentage demanded by these highwaymen is reported at from ten to fifty per cent.

On the few miles of railroad the charges have been most exorbitant. Between Yauco and Ponce, a distance of 18 miles, the passenger rate was one dollar and the freight rate twenty dollars per ton. Even under these conditions the island has flourished because of its surpassing fertility. Its mineral resources are absolutely undeveloped and, for the most part, unknown.

There is an abundance of water power, no less than one thousand two hundred small streams and twenty-one large rivers flowing into the sea along the coast, most of them being torrential streams descending the mountain slopes within a few miles of the coast. The flow is not intermittent, for even in the dry season these streams are full. In the rainy season many of them are raging torrents.

Almost the first proposition that has been made public for the complete exploitation of Porto Rico is the construction of electric tramways through the interior. It has not been proposed to build roads, for it is now well recognized that the most costly of ordinary means of transportation is that in vehicles drawn by animals over ordinary roads—especially in a hilly region. This project seems so eminently sensible, especially in view of the large undeveloped water powers of the island, and the fact that its whole area is so small that electrical power transmission from any part of it to any other is feasible, that it ought to be put into execution at the earliest possible moment. With immunity from the exactions of brigands, swift and inexpensive transportation from the interior to the coast, and relief from the various forms of legalized robbery that have existed, there is no reason why Porto Rico should not soon be one of the richest islands in the world.

The spectacle of electric tramways building in advance of ordinary roads is one that would have been even more startling five years ago than it is now; but even to-day it is an indication of the wonderful progress that has been made in the utilization of electricity and the readiness with which this agency lends itself to varied and useful purposes.

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THE advent of the United States in the east as a colonizing power makes the construction of a trans-pacific cable an actual necessity. There has been a considerable discussion of this subject in the newspapers for a long time, and it now seems that the cable must, of necessity, be laid, but there are engineering questions of great magnitude and importance to be answered before the actual work upon it can be begun.

Assuming that the United States will undertake the construction for themselves, or that they will subsidize a company to lay a cable to the Philippines from San Francisco, the first landing place would be in the Hawaiian Islands. The next possession of the United States is the island of Guam, in the Ladrones, which is about 3,100 nautical miles west of Hawaii. From this island to the mainland of Luzon, in the Philippines is about 1,650 nautical miles.

The longest cable now operated is that from Brest to New York, which is 3080 nautical miles in length. The cost of cables increases with their length in a geometrical ratio; the difficulty of working them increases about as rapidly. Remembering that the cost of the New York-Brest cable was greater than that of any other cable ever laid, it is readily seen that the construction of the American trans-pacific cable, involving the link between Hawaii and Guam, may well be approached with caution.

Of course such a cable as this would not have the volume of business that keeps the transatlantic cables constantly at work. Tolls would of necessity be high, service slow, because of the increased difficulty of rapid working in long cables and, indeed, it is much to be doubted if the investors in the enterprise would be rewarded with a dividend even under the most favorable conditions. This view of the matter, of course, assumes that the ownership of the cable is vested in private persons. If it is constructed this will doubtless be the method, there being much opposition to government control or ownership of telegraph lines in the United States, though it is conceivable that the government might lay such a cable as a part of its necessary and expanding military equipment. The solution of the difficulty is in the acquisition of an island of the Caroline group. If a landing can be made on one of the most easterly of these islands, the long step from Hawaii to Guam would be divided and, although no island of the Carolines is on the direct route of the cable, the loss due to the increased total length of the cable would be much more than compensated by the greater ease and certainty of working the shorter links, and the less cost of the individual lengths of the submarine construction.

In connection with the Pacific cable a very interesting question arises. From whence is the gutta-percha for this gigantic cable to come? Every whisper of the construction of a trans-pacific line sends the gutta market at Singapore up by leaps and bounds. The ruling price of the gum is the highest that has ever obtained. It is stated, on what authority it is hard to say, that the visible supply of gutta is insufficient for the task, and that if this cable is laid it will be the last—the last with a gutta-percha insulation, at least. While this pessimism on the part of the gutta producers savors somewhat of a desire to stiffen the market, there is yet a sufficiently reasonable foundation for it in the wanton destruction of the gutta forests. It will be interesting to see the outcome of the situation. If the United States acquires an island in the Carolines the building of the cable line seems possible, though expensive. If they do not find a landing place the operation of the cable seems to require a prohibitively costly plant. And meanwhile there is the question of the disappearing gutta tree.

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If recent reports are to be believed, we are to have a great shipbuilding plant framed on the lines of those at Jarrow, Elswick, and Barrow-in-Furness—ready to build, arm, and equip a warship complete. Mr. Carnegie and others have recently asserted that the United States were now so favorably situated, with reference to economic conditions, and progress in the iron and steel trades especially, that we could compete most successfully in the shipbuilding industry. We are already sending ship plates abroad; with our skill in labor-saving in mechanical construction, we should certainly be able to build them into ships at home.

The Newport News yard is, by the very fact of its comparative youth, probably the best arranged and equipped plant in existence. Now we are told that Vickers, Sons and Maxim contemplate installing a gun-making plant at Newport News in connection with the acquirement of an interest in Mr. Huntington's yard. This introduces the necessary element of acquired specialized experience. There is a lesson for us in England's quickness to take her capital and talent to the best market, wherever that may be.

THE BRITISH PRESS

Review of Leading Articles

The Coal Industry and National Progress.

IT is not uncommon for statisticians to attempt to measure the industrial condition of a nation by a study of some particular branch of trade, supposed to be of so general a character as to give a fair measure of the progress in all branches of industry.

Bank clearings, postal and telegraph business, the stock market, and many others have been used in this manner, but it is evident that these may vary from causes which do not necessarily give true indications as to legitimate business activity.

A paper in a recent issue of the *Colliery Guardian* points out the value of the indications of the coal trade as an index to general trade conditions, and draws some deductions as regards British industries. The production and use of coal lie at the bottom of so many manufacturing enterprises that the consumption of coal may be regarded as a fair indication of progress and prosperity ; hence some interesting conclusions may be drawn from the study of comparative statistics.

The position of England in this respect is peculiar, since she is not only the greatest producer of coal, but also the greatest exporter ; hence the coal production is a measure not only of internal industry, but also, to a certain extent, of foreign trade.

" If we could use the figures representing the output of coal as indicative of commercial and industrial supremacy, then would Great Britain's position be unquestionable. But, although every ton of coal worked, whether it is used at home or shipped to some foreign port, stands for labour employed and wages earned and revenue received, it is so much more important as a medium to creating additional value that we must look rather to consumption than to actual production."

Regarded in this light, all the coal exported by England to competing countries might be considered as so much aid and comfort furnished to the enemy,—a feature which is worthy of consideration.

Although Great Britain at present stands easily first in the matter of absolute production, America is rapidly approaching her output. Since nearly all the coal produced by the United States is consumed at home, its relation to outside trade is an indirect one, and must be considered separately.

Taking the leading coal producers of Europe, the most notable advance has been in Germany; France and Belgium having changed places, but without joint advance. Thus from 1860 to 1895 the relative productions expressed as percentages were :

	Great Britain	Germany	France	Belgium
1860	71.9	12.7	7.0	8.0
1895	59.9	24.6	8.6	6.3

" The position of Great Britain, therefore, as a producer of the source of steam power has, in relation to the other countries named, altered from 71.9 to 59.9 per cent., while Germany has contributed to the necessary power of the four nations 11.9 per cent. more than she did thirty-five years ago."

The actual quantity of coal consumed in each country is naturally more difficult of determination, but the available figures show that, while the consumption in Great Britain about doubled from 1860 to 1895, that in Germany trebled, and that in 1860 Great Britain used five times as much coal as Germany, and in 1895 only about twice as much. So far as consumption is concerned, Great Britain is, in the aggregate, far ahead of Germany, but the increase in coal consumption in the latter country indicates in a general way the manner in which she is threatening British industry in various directions.

Adding now the factor of the United States, we get an idea of the increasing importance of that country in the manufacturing world, and the potential force it will exert in the future. Going back only to 1870 and considering only Great Britain, Germany, and the United States, we have for the relative percentages of production:

	Great Britain	Germany	United States
1870	66.5	15.6	17.7
1895	43.7	17.9	36.6

Besides, in the matter of coal consumption the United States is already ahead of all countries, so little coal being exported that practically the whole of the raisings is consumed in the country itself for manufacturing and other purposes. In 1895 the total consumption, expressed in thousands of long tons, was:

Great Britain	159,045
Germany	72,094
United States	166,684

The remarkable position thus indicated for the United States shows that country to be already at the head of the nations as a manufacturing people, though as an exporting country Great Britain still maintains its supremacy, measured by its potential capacity in coal.

Rotary Converters.

THERE are a number of unexpected and somewhat puzzling actions which take place in a rotary converter, the explanation of which has hitherto been confined to a few publications of a mathematical nature. Indeed, the theory of the converter may be said to have lain buried in a mass of formulæ not over-easy of comprehension, until Professor Silvanus P. Thompson read a paper on the subject at the last meeting of the Institution of Electrical Engineers. This presents, for the first time, to readers of English, a consistent and simple theory of the operation of rotary converters — called by the author "rotatory converters" — and a summary of the entire literature of the subject. The clear and even elementary nature of Professor Thompson's explanation renders his paper one of especial value.

After a general statement of the theory of the machine, the author remarks at length upon the anomalies of heating in the armatures of rotaries operating on single-phase and polyphase circuits. A number of diagrams are given, showing the instantaneous values of current in the armature coils under different circumstances of commutation and phase relation; and the rather interesting question of alteration in the voltage ratios of the two sides of the machine by changing the shape of the alternating-current wave—or, in other words, by altering the width of the polar embrace—is discussed at some length. The paper closes with a description of a number of designs of rotary converters, including the ingenious and remarkable machine of MM. Hutin and Leblanc, which is better known by its barbarous French name of ***panchahuteur*** than by the equally strange title of "permutating machine" given it by the author.

Excellent and valuable as Professor Thompson's paper is, it is marked by a few omissions of really essential facts of the theory of the rotary converter. There is practically no discussion of the enormous increase of heating in these machines due to displacement of phase between the current and electromotive force on the alternating side, or any consideration of one of their most valuable features in practical work—their ability to act, like synchronous motors, as phase replacers. A rotary working on an alternating system is, to all intents and purposes, a synchronous motor, and proper manipulation of its field excitation causes the machine to impress either a leading or lagging phase on the line current. Consequently a rotary can be used to rectify any displacement of phase on the line, due either to the capacity or induction of the system, by introducing a compensating displacement of the opposite sign. A singularly beautiful case of the regulation of voltage on a large American power-transmission system in this way has recently been described at some length by Mr. C. P. Steinmetz.

Professor Thompson's paper will be of real use to students of the subject, because it presents the theory of the rotary without mathematics and in as simple and intelligible a way as seems possible when the somewhat intricate character of the subject is considered.

The Influence of Exhibitions.

In the inaugural address of Mr. George Russell before the Institution of Engineers and Shipbuilders in Scotland a number of interesting points are brought out, and among these is the view which he takes of the advantages and disadvantages of international exhibitions, so far as the exhibitors are concerned.

After briefly reviewing the progress of such exhibitions from 1851 to the present time, Mr. Russell proceeds to discuss the influence which has been exerted by them.

"The tendency of international exhibitions has been to spread knowledge—which was formerly local or national—over the whole world. Fifty years ago Great Britain was far in advance of other countries in engineering, shipbuilding, and general manufactures. The exhibition of machinery in motion, showing processes of manufacture, enabled the foreign visitors to copy and emulate them in their own countries, and then establish competing centres for supplying the markets of the world.

"The effect commercially on Great Britain of such exhibitions has thus not been beneficial, but the reverse. Knowledge, however, cannot be confined to any one country or locality in perpetuity. It is bound to spread ultimately over the whole world. But these exhibitions have greatly accelerated the process, and shortened by many years the period of Great Britain's lead in engineering matters. By exhibiting all we knew, foreigners were able to get the benefit of our experience, and save the long and tedious time of evolution.

"Fifty years ago the advantages of these exhibitions were very unequally divided, but at present they are more nearly balanced.

"The most advanced practice in engineering and shipbuilding is no longer confined to Great Britain, for machinery of every class as complete, efficient and powerful, and steam vessels as large and speedy, are produced in America and on the continent. Indeed it is very noteworthy that the three largest steamers of last year were built in Germany, and that at present that country has the honor of of holding the 'blue ribbon' for speed in Atlantic voyages."

While there is much truth in the fact that international exhibitions have done much to disseminate knowledge and promote competition, it is not so certain that this has been an injury, even to the nation which has had the most to give. The stimulus of international competition must react upon the giver and prevent the tendency to decay and the disposition to rest upon past earned laurels, and there is no surer inducement to nations and individuals to push forward in the struggle than such displays as have been given at past exhibitions, and may be expected in the coming one.

It is quite possible to imagine that if there had been no international exhibitions during the past fifty years, England might have a greater lead in industry and commerce over other nations than she now has, but it is a matter for question whether her absolute advance would have been so great as it is in fact. The spur of competition may have been sharp, but it has been the cause of progress which would not otherwise have been obtained.

It is a matter of common note that the most advanced and successful establishments are also those which are most liberal in the disclosure of methods and products, and that manufacturers whose works are surrounded with secrecy are usually in possession of little or nothing which is worth acquiring. Be this as it may, it is quite certain that exhibitions will continue to be held, and that all progressive nations will participate, and the progress of the world will thereby undoubtedly be advanced.

Polyphase Traction.

The question of the use of polyphase motors for traction is one of perennial interest, and a matter of such importance that it is to be regretted that so little experimental data concerning it have been accumulated. So far, there are but two or three railways, mostly short and unimportant lines, using the polyphase motor on their cars, and these, being of special type, have not afforded an opportunity for the development of a proper control system for the induction motor.

The *Electrician* sums up the whole case of direct current *vs.* polyphase traction in a recent editorial, and concludes that, "on the whole, both from the point of view of inductive and earth-current disturbance and of economical and practical working, the advantage, at any rate at present, lies with the continuous-current motor." The argument upon which this conclusion is based is that the various external disturbances due to an electric railway are inherently more difficult to eliminate when it is operated by alternating currents, and that the difficulty of regulating the speed and torque of a polyphase motor are very great. While it is likely that the justice of this position will be admitted, even by the most ardent advocates of the polyphase system, there are certain intrinsic advantages possessed by the alternating-current distribution systems—notably the possibility of eliminating sub-stations for an extended distribution, the simplicity and mechanical strength of the generating apparatus, and the possibility of long-distance working from a single station—which point to most elegant solutions of many difficult electric traction problems.

There is now ample evidence that a two-conductor system will work admirably in a conduit. A three-conductor system—requisite for polyphase transmission—would almost certainly work as well. If any system of control can be devised whereby the torque and speed of an induction motor may be varied and regulated with an ease and certainty approaching that of an ordinary direct-current motor, the vast superiority of the alternating-current conducting system will result in the installation of many railways equipped with polyphase apparatus throughout, instead of with the less efficient combination of polyphase generator, transformers, and direct-current motors.

Meanwhile, however, the practical advantages appear to lie with the direct-current system, but the problem of designing a proper polyphase traction equipment does not seem insoluble.

The Formidable and the New Maine.

THERE was launched recently, at Portsmouth, the largest battleship yet constructed, H. M. S. Formidable. This magnificent vessel, which is fully described in the *Engineer*, possesses many points of novelty in design and equipment, which, when considered with her great size and powerful armament, make her of peculiar interest.

Of the external features of the design perhaps the most striking is the cutting away of the deadwood aft and the keel forward for considerable distances. It is believed that this will greatly facilitate the turning of the ship, and assist evolutionary movements to a marked degree. The stern-post is a solid steel casting, descending for eleven feet below the recessed stern and forked out forward and aft beneath the tiller compartment to assist in stiffening the stern framing. The ram bow is a single casting, running from the stern to the ram proper, which is shaped like a gigantic thimble. Sloping up to the ram for a distance of forty-five feet are the vertical and flat keels, which are securely bolted into it. Into the ram is also inserted a horizontal forty-pound stiffening plate, running back to the seventh frame bulkhead, the eighth being the collision bulkhead proper. The ram may thus be driven in a considerable distance, without injury to this important bulkhead.

It is interesting to note the comparison between the details of this ship and its armament, and those of the three new battle-ships, now under construction for the United States navy, published in a recent paper by Chief Constructor Philip Hichborn. The Formidable is 430 feet long over all, 75 feet extreme beam, and 26 feet 9 inches draught at normal displacement of 15,000 tons. The Maine, which is a type of the new United States ships, will be about 394 feet over all, 72 feet feet beam, and 23 feet 10 inches draught at 12,500 tons displacement. The Formidable is provided with 15,000 h. p., 1 h. p. per ton displacement, while the Maine will have 16,000 h. p., or 1.28 h. p. per ton displacement. The speed expected from each vessel is the same,—eighteen knots,—but the Maine seems to have somewhat the better chance of attaining, or even surpassing, this velocity. The Formidable has bunker capacity for 2,100 tons of coal, the Maine for 2,000 tons.

Both vessels are to have water-tube boilers. The Formidable will be provided with twenty independent Belleville boilers, supplying steam at 300 pounds, which will be reduced to 250 pounds at the engines. The Maine will be equipped with Niclausse boilers, twenty-four in number, working at 250 pounds' pressure.

Turning now to armour, the British ship has 9-inch side armour, 15 feet deep and extending fore and aft 216 feet. By diagonal armoured bulkheads the total length of the citadel is made 250 feet. The slopes of the armoured deck are three inches thick, all the armour being Harveyised steel. Forward of the citadel the sides are protected with a 2-inch Harveyised steel belt, while there is a flat 2-inch armoured deck forward and a similar flat 3-inch armoured deck aft. The gun hoods for the main battery are 8 inches thick, and the armoured redoubts or batteries, containing also the hydraulic mechanism, are 12 inches thick. The sponsons in which the secondary battery is mounted are 6 inches thick.

The Maine will have 12-inch side armour 4 feet 6 inches high, from one foot below the mean load water-line, and 8½-inch armour below this for 3 feet. Above this main belt her side armour is 5½ inches thick. The superstructure armour is to be 6 inches thick, the turrets for the main battery 15 to 17 inches, the barbette armour 10 to 15 inches, the protective deck armour 2¾ to 4 inches, and the conning tower 10 inches.

In gun power there is a similar disproportion between the ships. The Formidable is to mount four 12-inch wire-wound guns, twelve 6-inch quick-fire guns (of which eight will be on the main deck and four in corner casemates on the upper deck), sixteen 12-pounder quick-fire guns, and two 12-pounder field guns. In her tops she will carry six 3-pounder Hotchkiss guns, and eight small Maxim guns will be mounted on the superstructure. The vessel is also provided with four submerged 18-inch torpedo tubes.

The Maine will carry four 13-inch guns, fourteen 6-inch quick-firing guns, 20 6-pounders, six 1-pounders, 4 Gatlings, and 1 field gun.

This brief comparison shows that, while the Formidable is the larger ship, the Maine is superior in weight of armour and power of armament and far superior in horse-power of machinery in proportion to displacement. The British ship has the better secondary battery, her sixteen 12-pounders outclassing the twenty 6-pounders of the United States ship; but it is doubtful if, in case of a torpedo attack, the greater number and handiness of the Maine's 6-pounders would not more than compensate for their smaller calibre. In main battery the Formidable is distinctly inferior, not alone in the smaller size of her great guns, but in carrying two less 6-inch guns than the American ship.

In coal capacity, and hence in steaming radius, the two ships are more nearly alike, but the greater bulk of the Formidable more than compensates for the superiority of 100 tons in her coal-carrying ability. The two types probably represent the highest achievement in battle-ship design, and their trials will be awaited with no little interest on both sides of the Atlantic.

High-Pressure Steam as a Mining Explosive.

THE frequent occurrence of coal-mine explosions has led to a very considerable amount of research upon the nature of fire-damp, and to no little invention of new blasting explosives and processes. Among these none more remarkable has been suggested than that presented by Major General H. Schaw at the recent Birmingham meeting of the Institution of Mining Engineers. In brief, his process of blasting is by the use of a steel cartridge partly full of water, which is heated, by means of a platinum wire and the electric current, until the expanding steam bursts the shell and brings down more or less coal. It is proposed to so regulate the strength of the cartridge case that it will burst at about 150 pounds pressure per square inch. Such a contrivance, 1¾ inches in diameter and 3½ inches long, could be brought up to this pressure in about ninety seconds with a current of 160 amperes at 60 volts —or about 25 h. p. The platinum wire is 6.1 inches long and 0.013 inches in diameter, and is immediately vapourised in a atmosphere of steam when the explosion of the cartridge removes the cooling water from contact with it. Such a cartridge will exert a force of about 1⅓ tons. It is needless to say that it will be safe to handle and apply; but it is greatly to be doubted if it will be safe to explode such a cartridge in a fiery mine.

If a conductor having a difference of potential of 60 volts at its ends is immersed in water, the effect will not cease at the heating of the wire and boiling of the water, but will include a copious decomposition of the water with freeing of oxygen and hydrogen in their most explosive proportions. Indeed, it is extremely likely that this effect would be the more marked of the two. In such a case, if the water-level lowered, so that the platinum became exposed to the mingled gases and steam, its affinity for hydrogen, even if there were no electric current to assist, would immediately bring it to a red heat, and determine an explosion of a very violent and flaming character—precisely the kind the inventor seeks to avoid.

The Mond Nickel Extraction Process.

THE existence of a volatile compound of nickel and carbon monoxide—discovered about ten years ago by Dr. Ludwig Mond—is not simply a curiosity of chemistry; the compound appears to be destined to play an important part in the nickel extraction industry.

Nickel carbonyl is described at length in a paper by Professor Roberts-Austen lately read before the Institution of Civil Engineers. It is a liquid, readily distilled without decomposition, but which, when heated to 150 degrees centigrade, decomposes with deposition of nickel, the carbon monoxide going off as gas.

So promising was this discovery, it being found that the nickel carbonyl was readily obtained by the direct action of carbon monoxide on nickel matte, that after a number of experiments on a laboratory scale a small works was erected at Smethwick, near Birmingham.

The process begins with bessemerised matte, which is first dead roasted, after which it contains about 35 per cent. nickel, 42 per cent. copper, and about 2 per cent. of iron. The second part of the process consists in the extraction of about two-fifths of the copper by sulphuric acid, the copper sulphate obtained being crystallised and sold in that form. From this process the residue contains about 51 per cent. of nickel. Reduction of the nickel is then accomplished in a shelved tower, the reducing agent being the hydrogen contained in water-gas. The temperature at this stage should not exceed 300 degrees.

From this tower the ore is continuously carried over to another tower in which the process of carbonyl formation and volatilisation is carried on, a stream of carbon monoxide at a temperature not exceeding 100 degrees centigrade flowing over the ore. The carbonyl vapour passes to still another tower, or a retort, and is there heated to a temperature of 180 degrees centigrade, when the nickel is deposited, either on thin sheets of iron or on nickel granules. The carbon monoxide released from the nickel carbonyl is returned to the volatiliser to be used again.

The partly extracted ore from the volatiliser is returned to the reducer and thus passes back and forth for a period of from seven to fifteen days, or until about 60 per cent. of the nickel present is removed as nickel carbonyl. The residue from this operation amounts to about one-third the original calcined matte and differs little from it in composition. It is removed and added to the matte in the first operation, and thus returns through the cycle of operations until all the nickel is extracted.

The product contains 99.8 per cent. of nickel. About 80 tons have been produced, and the process is said to be able to compete with any other for the production of metallic nickel.

American Expansion and Trade.

A RECENT editorial in *Engineering* deals with the questions which have arisen because of the inevitable expansion of American influence in matters commercial as a consequence of the Spanish war, and some of the views expressed are well worthy of careful consideration.

"The great industrial development which has taken place in the United States in recent years has made an extension of foreign markets a necessity. American competition is being keenly felt in certain departments in some of the countries of Europe and in the Far East, and before long it is certain to be felt still more.

"With the enormous and enormously-increasing productivity of the American Union, trade will become more and more an absolute necessity of industrial existence. It will naturally be found towards what we call the Far East, in Australia, and throughout the wide Pacific area. Before that valve can be made fully effective the engineer must be called in to make the necessary connections. The Nicaraguan canal must be completed, not only for the purpose of giving a shorter route from the manufacturing eastern States to China, Japan, and the Far East, but also for the whole of the South American coast. We need not meantime discuss all the possibilities raised in connection with that undertaking; it is admitted by all who have studied the subject that they are great, and it is certain to give a great impetus to the development of the Pacific, both commercially and politically.

"On the other hand, we have the Trans-Siberian railway, connecting the Far East with Europe, and it is certain soon to be connected with the main lines in China, which will open up immense fields for trade and industry. Hawaii and the Philippines will not only be important possessions in themselves, but will also be stepping stones in the Far East, as well as important naval stations, which will enable the United States to dominate the Pacific. A recent writer has estimated that nearly three-quarters of the whole population of the globe is to be found on and bordering on the Pacific area. What a prospect this opens up for an energetic and ambitious people, not only for industrial and commercial development but also for political and civilising influence! If the United States were joining hands with Great Britain, their power would be irresistible, and it is certain it would only be used for the advancement of progress and civilisation, with a due regard to the interests and feelings of all other nations of the world."

Etheric Telegraphy.

IN a late issue of *The Engineer*, Mr. W. H. Preece gives a very interesting account of some of the earliest experiments in telegraphing between distant points without the use of a communicating wire, citing especially the facts that a message was sent by him without wires over a space of 3.3 miles in November, 1892, and that he received a message from Lord Kelvin which had been sent through space between Alum Bay and Bournemouth in July of 1898. "In each of these cases wires were used at the terminal points to control, direct, and transform the energy used, but the medium for the transmission of the disturbances that were translated into words was the ether," For this reason Mr. Preece objects to the term "wireless telegraphy" and also finds the German name "spark telegraphy" undesirable, preferring the expression "etheric" telegraphy. It will be recalled that Professor Silvanus Thompson has already suggested the term "space telegraphy," and either this or the name given above by Mr. Preece may be used to advantage.

The fact that electric currents may be transmitted without wires has long been known, and the existence of stray currents in the earth, and of the inductive action of electric waves, has been the prime reason for the use of metallic return circuits for telephones. Attempts have been made during the past ten years to utilise the telephone as a transmitter and receiver over varying distances and with some measure of success.

"All the earlier experiments were made with coils of wire and with metallic circuits embracing wide areas, but it was soon found that single wires dipping in the earth at each end were equally effective and at short distances gave better results. Across Loch Ness, a distance of one mile and a quarter, it has been found possible to speak by telephone. Earth conduction came in as a friend to assist the result, but it is very easy to show that the prime effect is etheric. A gutta-percha wire floating on the surface of the sea three miles away, with its ends making earth in the sea, is affected and emits sounds; but if it sinks below the surface all sounds cease, and the telephone is no longer affected."

These earlier methods, however, have been superseded by the use of electric waves or impulses of high frequency, and it is mainly of Marconi's practical experiments in the use of electric waves for the transmission of intelligence that Mr. Preece writes.

"These waves permeate space just as light waves do, and the distance to which they extend is apparently unlimited, but the distance at which they are recorded depends simply on the delicacy of the apparatus—the electric eye—used to detect their presence.

The waves are excited by an ordinary induction coil, and received by a very delicate detector discovered by Branly, called by Lodge a "coherer," and converted by Marconi into a telegraph relay.

This relay consists of a glass tube about 1 inch long and ⅛ inch in diameter, into the ends of which are fitted two silver pole-pieces separated from each other by a space of about 1-50 of an inch, this space being lightly filled up with a mixture of fine nickel and silver filings. The tube is then exhausted to a high vacuum and sealed. In this normal condition the metallic powder is an insulator and allows no current to pass through it. But let an electric impulse fall upon it, and its condition changes, order is impressed upon its discordant ranks, it becomes a conductor, it coheres and allows a current to pass. This will continue until it is tapped, or mechanically shaken, when it instantly returns to its previously insulating state, and is in fact decohered,

Marconi decoheres by making the current itself vibrate a small hammer against the glass tube, which in striking emits a sound. Such sounds can be formed rhythmically into a telegraphic language or the current so set up can actuate a Morse or Kelvin recorder, and print the messages in dot-and-dash letters.

The extent to which such apparatus can be utilised in practice remains to be demonstrated, the most successful trials having been made at sea, where communication has been held over a distance of fifteen miles.

Mr. Preece is of opinion that the field for the use of etheric telegraphy is limited "except if it be made practical between ship and ship and between ship and shore. This is the region where the system would be not only useful but beneficial."

THE CONTINENTAL PRESS

Review of Leading Articles

Metric Screw-Thread Systems.

ALTHOUGH the metric system has now been in use in nearly every industrial country on the continent for many years, there is yet no standard system for metric screw threads, and there is no assurance whatever that any metric nut will fit any bolt of the same diameter, as either the pitch or the shape of thread, or both, may be on different systems from that of the nut. This is not because there has been no attention given to the subject of metric screw-thread systems; on the contrary, many such systems have been proposed; the trouble appears to be that of too many systems rather than too few.

It is doubtless for this reason that in very many of the large establishments on the continent the Whitworth screw-thread system is used, not only as regards pitch and form of thread, but also for diameter of bolts; so that, while all other dimensions of a machine may be in metric units, the bolts and nuts will be found to be in English sizes, and conforming to the Whitworth standard. The inconvenience of this use of two systems of measurement is undoubtedly offset by the fact that standard gauges, taps, dies, and nuts can be procured without difficulty, and with the assurance that they will interchange wherever found.

The attempt to secure a standard metric screw-thread system, however, has not been abandoned, and the latest effort in that direction is that put forth by the congress for the unification of screw-threads which has recently closed its sessions at Zurich.

From the report made public in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, and from the discussion of the German Railway Society published in *Glaser's Annalen*, the especial features of this latest metric candidate for public favor are obtained.

Switzerland is eminently adapted for the discussion of any international matter, since the jealousies which might arise elsewhere can be better controlled, and the prospects of united action thereby advanced.

The real difficulty with the metric screw-thread systems is the unsuitability of the millimetre as a unit of progression, if the decimal system is to be preserved. In the English system of Whitworth, and the American system of Sellers, the continual bisection of the inch makes the sixteenth of an inch a convenient rate of progression for bolt-diameters without departing from the general practice of shop measurements, while the pitch is expressed in an integral number of threads per inch in nearly all cases, in a form which can readily be produced on any screw-cutting lathe when desired.

In the metric system, on the contrary, a progression of diameters by even millimetres is practicable only up to 10 or 12 millimetres, after which it advances by 2, 3, or 4 millimetres, according to the system which is used; in fact, in many cases the advance is not uniform in the same system. Thus, in the system of Delisle, used to some extent in Germany, the following successive diameters in millimetres show the entire absence either of decimal or bisecting system: 30, 32, 36, 39, 42 mm.

The pitch also, in many cases, shows a similar disregard of system, being very very generally in fractional parts of a millimetre, and, curiously enough, often in halves and quarters of millimetres, with utter neglect of the fundamental decimal feature which is supposed to be the metric cornerstone. It is not to be wondered, therefore, that many manufacturers have retained the Whitworth system, not because of any especial merit, but because some standard must be had, and there is no metric standard.

The system which bears the favourable recommendation of the Zurich commission may provide the much-desired standard, but it may also add but one more to the sixteen systems now extant—we cannot say in use.

So far as profile of thread is concerned, that originally proposed by Sellers is recommended, the angle being 60°, the apex of the equilateral triangle being flattened by one-eighth of the altitude. The rounded profile of Whitworth is thus abandoned, as are also the angles of 55° and 53° 8′, recommended by Whitworth and by the Verein Deutscher Ingenieure, respectively. The decimal system, however, is cast to the winds, both as regards bolt-diameters and pitch of threads, the former advancing by single millimetres up to 12 mm., by two millimetres up to 24 mm., by three millimetres up to 48 mm., and by four millimetres thereafter; while the latter advances by half and quarter millimetres from one up to seven millimetres.

This is practically the system previously proposed by the Société d'Encouragement, with the slight modification of the introduction of the quarter- and three-quarter-millimetre advance in pitch for certain of the sizes; under the circumstances it is probably the best that can be done. The commission evidently foresaw that other diameters might be desired; hence it is provided that any intermediate diameter may be used between those given in the regular series, the pitch of the nearest lower diameter being used in such cases.

Whether the new system will come into general use or not remains to be seen. It has been shrewdly remarked, in reference to the somewhat similar subject of gauges for the thickness of sheet-metal, that it is very much easier universally to adopt a new system than it is universally to throw away an old one, and we apprehend that the discarding of the systems now in use will not make very rapid progress, in view of the experience of the past.

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High Speed Compound Locomotives.

DURING the past year a very complete series of tests has been made on the Northern Railway of France upon the new type of four-cylinder compound engines designed for high-speed service by M. du Bousquet. The detailed report of these tests has been given in recent issues of the *Revue Générale des Chemins de Fer*, and an excellent *résumé* by M. Barbier appears in *Le Génie Civil.* The completeness of the tests will be appreciated when it is understood that more than four hundred diagrams were taken at speeds ranging from thirty-seven to seventy-five miles per hour, together with corresponding readings of a traction dynamometer, for various positions of throttle and degrees of cut-off. The boiler pressure was maintained uniformly at about 215 pounds per square inch (15 kilogrammes per square centimetre), and every precaution taken to render the trials more complete than any which had hitherto been made.

The general construction of the engine may be briefly given. Of the four cylinders, the outside ones are high-pressure, and are 13.4 inches bore by 24 inches stroke. The low-pressure cylinders are inside, the dimensions being 21.9 inches bore and 25.2 inches stroke, the Walschaert valve-gear being used in both cases. There are four coupled drivers, 83.2 inches in diameter, the forward pair being driven by the low-pressure cylinders, and the rear pair by the high-pressure cylinders, and, of the total weight of 50 metric tons, 31 tons is upon the driving wheels. The cranks of each pair of high- and low-pressure cylinders are placed at an angle of 180° with each other, while the cranks on opposite sides of the engine make an angle of 90°. The boiler contains 107 tubes, 12 feet 10 inches long, and 2.54 inches in internal diameter, and the total heating surface is 1,885 square feet, of which 122 square feet is fire-box surface and the remainder in the tubes. The grate area is 23 square feet.

An examination of the combined indicator diagrams from both sets of cylinders, taken at moderate and high speeds, shows a number of points of interest, which may be taken as belonging to compound engines in general as adapted for locomotive service, since this engine represents general compound practice without any peculiar innovations.

The loss of pressure between the boiler and the initial pressure of the high-pressure cylinders appeared as a direct function of the opening of the throttle and an inverse function of the speed, and averaged from 30 to 35 pounds per square inch, or about one-sixth of the boiler pressure. This includes both the wire-drawing action of the valves and the initial condensation in the cylinder; and in this connection it may be noted that the expansion curve was in all cases below the isothermal.

As each cylinder was provided with its own valve gear, and the relative degree of expansion could thus be changed, it was possible, during the trials, to investigate the influence of changes of cut-off in the high- and low-pressure cylinders. An increase of speed, as a rule, caused a reduction in the total area of the diagrams, while a wider opening of the throttle increased the area. When the high-pressure valve gear was notched up to an earlier cut-off, the correspondingly-increased compression caused an increase in the receiver pressure, which again appeared in the low-pressure cylinders, while a later cut-off produced a lower initial in the low-pressure cards, but a greater area.

The trials included attempts to attain successively three different results: first, an equal division of work between the high- and low-pressure cylinders, as conducing to minimum wear; second, the production of the maximum power; and, third, the attainment of the greatest economy of steam.

In regard to the first point, it was found to be secured practically when the degree of cut-off was the same in both cylinders, the relation varying but slightly with changes of speed. The maximum power, however, as shown by the diagrams, was attained by prolonging the admission in the low-pressure cylinder. At speeds of sixty miles per hour an increase from 0.45 to 0.70 in the low-pressure cylinder, with a fixed cut-off at 0.45 in the high-pressure cylinder, showed an increase in power from 930 h. p. to 1,080 h. p. A similar relation appeared to exist as regards steam-consumption, and careful computations of power developed for steam consumed showed that the best economy was secured by permitting the steam to follow the low-pressure piston for the greater portion of the stroke, the cut-off in the high-pressure cylinder remaining constant. Under these conditions the steam-consumption per effective horse-power-hour was 25.5 pounds, at a speed of 37 miles per hour, and 40 pounds, at a speed of 75 miles per hour.

In practice it was found that the best results were obtained with the throttle about two-thirds open, the wire-drawing thus obtained partially superheating the steam and removing all "hammer-blow" action in the pipes. As a result of these trials, it appears that for high-speed compound locomotives of this type the best ratio between high- and low-pressure cylinders is 1 : 2.4.

The favorable impression made by the performance of this type of locomotive is shown by the fact that twenty additional engines of the same design have been ordered by the Northern Railway of France, to be used in the express service, which now has the reputation of being the fastest on the continent.

The Riga-Kherson Ship Canal.

Some months ago the proposition to construct a ship canal connecting the Baltic to the Black Sea was noticed in these columns, and a further account of the project is now given in a recent issue of *La Revue Technique*.

The present is undoubtedly a period of interest in ship canals, the advantages of such great waterways being more and more generally appreciated. Some of these are intended only to permit loaded vessels to reach manufacturing centres without breaking bulk and re-handling cargo, others are intended to shorten sea routes by cutting through isthmuses, while still others are projected to effect communication between lakes and inland seas, all having for their main purpose the extension of that most economical mode of communication, water transport.

The extent to which this subject has been developed in recent years, may be indicated by a brief reference to some of the more important waterways which have been constructed or are now in course of construction. In England, the Manchester Ship Canal; in Germany, the Baltic Canal; in Belgium, the canals from Ghent to Terneuzen, from Bruges to Heyst, and from Brussels to Rupel; in France the canals from Caen to the sea, of Saint Louis, and of the Loire; and in Japan, the canal from the sea of Japan to the bay of Osaka.

In addition to these there are numbers of important internal waterways in course of construction all over Europe, which, while not to be included in the list of ship canals, yet indicate the great technical and commercial interest which is being taken in the transport of merchandise by water.

The latest, and greatest of these waterways, if measured by extent, and second only to the piercing of the American isthmus, if reckoned by importance, is the great work proposed in Russia, to which reference has already been made. As indicated on the map, it appears that between the slope of the Carpathians and the high lands of Valdai and Koursk, there exists a depression, which at no point reaches a greater altitude than 120 metres above the sea, and within which are found the Duna, the Dnieper and the Beresina. The Duna flows northward into the Baltic, while the Beresina flows into the Dnieper and the latter into the Black Sea. The head waters of both these systems are found in the low lying land between the mountains, and the proposed plan includes the canalisation of both streams and their connection into one continuous waterway by an artificial channel.

By thus using two navigable streams, having their origin in the same moderately elevated valley, the peculiar result is attained of a canal without locks in spite of the fact that there is a difference in altitude of 120.79 metres between the extreme levels. The conditions in this respect are somewhat similar to those found in the canalisation of the lower Danube, in which the canal constructed by the side of the cataracts of the Iron Gates converts a succession of waterfalls into a gradual slope without locks, merely by enclosing a portion of the stream between two longitudinal dykes, and extending the fall over a sufficient length to keep the velocity within reasonable limits. This method of construction is especially applicable to the proposed canal from the fact that the country between the Beresina and Meritza contains an abundance of water, and very moderate slopes. By the construction of movable dams and weirs it will be possible to control the water supply for the canal in such a manner as to maintain practically a uniform current, while any excess will be available for purposes of irrigation.

A large portion of the work will consist in the dredging of the beds of the rivers and the control of the channels by the limitation of the flow of water by embankments, while at the terminal ports of Riga and Kherson great docks, 300 by 200 metres are to be built. The two lakes of Beresina and Pripet are already centres of a vast grain trade, while numerous towns along the rivers furnish ports awaiting development.

The commercial advantages of this canal are not limited to the through traffic, although it is estimated that this would attain 10,000,000 tons per annum. It is rather anticipated that such an internal waterway would provide a means for extensive local transport of grain and other merchandise, assist in the development of coal and other mineral resources, and provide for the drainage of a large area of marsh land.

The estimated cost of the work is 500 million francs, of which 80 million are for expropriation damages, 228 million for dredging and excavation and 72 million for embankments, this sum to be raised by an issue of bonds guaranteed by the government, bearing 3 per cent. interest, and running for a term of 70 years.

There are many points for serious consideration about such an extensive project, not the least of which is the uncertainty of the immediate attainment of sufficient traffic to meet the interest charge on such a large initial cost. The constructive difficulties are by no means insuperable, and the military value of the canal is ample inducement to the government to insure its completion should the work be definitely undertaken. It must not be forgotten that the canal would be closed to traffic at least three or four months in the year by reason of the cold, and that the bulk of the profitable use of the waterway must be concentrated in a period of about six months.

The Kornhaus Bridge at Berne.

NEARLY two years ago the commencement of work upon the great Kornhaus bridge across the valley of the Aar at Berne was noted in these columns, and now we have to notice the completion of the work as described in a very fully illustrated paper in the *Zeitschrift des Vereines Deutscher Ingenieure.*

The promontory upon which the old city of Berne was originally placed has long since been outgrown and upon all sides of the loop of the Aar have grown up suburbs which require ready communication with the old town. The stone arch of the once famous Nydeck bridge was the first attempt to provide a high-level roadway, and this was followed by the railroad bridge, the Kirchenfeld bridge, and the present structure, which since it extends from the Kornhausplatz to the Spitalacker, is known by the name of the former place; besides which there is the Lorraine bridge, as yet uncompleted.

The finished Kornhaus bridge does not differ materially from the description given in these columns in November, 1897, the total length of nearly 1200 feet being composed of four arches on one approach and one on the other side, each of 118 feet span, and the one great steel arch of 407 feet clear span over the Aar. On each side of the river rises a masonry pier over a hundred feet high, the main arch springing from the bases of the piers, and the approaches extending from them to the banks between smaller piers.

Owing to the manner in which the ground beneath Berne and its surroundings is permeated with ground-water, much difficulty was experienced in securing satisfactory foundations in the sloping banks for the great piers, it being necessary on one side to excavate to a depth of over 90 feet in the sliding moraine before a bearing in solid rock could be secured.

Many interesting details are given showing the manner in which the difficulties of construction and erection were overcome, and the whole work forms a good account of a form of bridge construction which is greatly in vogue at the present time.

The completion of this fine work leaves only the Lorraine bridge to be finished in order that Berne may possess fine examples of both steel and masonry arches, and a visit to the capital of Switzerland will soon be a pilgrimage of instruction for all who are interested in this branch of engineering.

Public Works in Paris.

THE condition of the city of Paris at the present time is that of general upheaval, and in the technical journals may be found ample evidence of the progress of the important engineering works which are now being pushed forward with energy.

Prominent among these are the works directly connected with the coming exposition, while others are indirectly due to preparations for the same event. Among these latter are included the Metropolitan Railway, the new terminus of the Orleans railway on the Quai d'Orsay, and the Alexander III bridge across the Seine.

A recent issue of *Le Génie Civil* contains interesting accounts of the progress of work upon the last two undertakings, with many illustrations showing the existing conditions.

The construction of the Orleans station is especially interesting as it includes the demolition of the ruins of the Cour des Comptes, which had been standing since the fire in the days of the commune. The principal difficulty encountered in this work was the danger in levelling the tall walls without floors, and it was found necessary to proceed at first with extreme caution in order to avoid accidents. The demolition was begun in April, 1898, and completed in August, and of the 30,000 cubic metres of material removed in four months about 10,000 cubic metres of cut stone were found available for use in the new structure.

The removal of all this débris, as well as of the material excavated from the site to provide the space for the lower train floor, required special arrangements, as no interruption in travel on the surrounding streets or on the Quai d'Orsay was permitted. A subway was therefore made under the quay leading to the bank of the river and through this tunnel the earth and material has been removed to barges. In constructing this passage it was found necessary to cut partially into the large collecting sewer which passes along the side of the river under the quay, and the floor of the tunnel at this point is supported upon I beams. In conducting the excavations the massive foundations of the old building were uncovered and revealed the solidity of the old work.

The site now exhibits an appearance of great activity, work being pushed forward by day and night, and it is expected that the foundations for the railway tracks, station, and terminal hotel will be completed by the end of January, 1899, after which the erection of the superstructure will proceed rapidly. In the meantime the prolongation of the subway beneath the quay along the left bank of the Seine is being carried forward, so that by the time the new station is completed the connection with the old terminal at the pont d'Austerlitz will be made.

The work on the Alexander III bridge is now making satisfactory progress, the great caissons of the piers for the arch having been sunk to rock foundation and the masonry work required to resist the thrust of the arch practically completed.

The false works for the support of the hinged arch during erection are now in place, and are so arranged that navigation in the Seine is not materially interrupted; there is every reason to believe that this handsome addition to the bridges of Paris will be completed as originally intended by the close of 1899.

Russian Railways in Asia.

THE value of the railway as a means of penetrating new countries is fully appreciated by the Russian government, and a paper by General Annenkoff in the *Bulletin of the International Railway Congress* describes in a very interesting manner the construction of the Transcaspian railway. This road, which extends from the Caspian to Samarkhand, was constructed primarily as a military railway, but has proved a most efficient civilizer and, by bringing the towns in the interior of western Asia into communication with Europe, has promoted commerce to a marked extent.

The constructor of the line had originally intended to dispense with manual labor as much as possible and use machinery, and with this object in view he ordered machinery from America. This idea, however, fell through when the natives found how much they could earn at the piece rates offered by the constructor, and the large number of capable men who offered their services made it possible to conduct the work by manual labor so rapidly and cheaply that the use of the machinery was practically abandoned. The general control of the work was in the hands of Russian soldiers forming what are called railway regiments.

These railway regiments had been organized on the following principle: the regiments received into their ranks recruits who, before being called upon to serve, had been educated in technical schools, in railway schools, in the schools of mines, forests, or metallurgy; they recruited also mechanics, blacksmiths, locksmiths, and carpenters.

Among these men were many who were capable of superintending railway-construction work, and with these and with the native laborers a very efficient force was obtained.

The general account of the manner in which the detailed work was executed with this peculiarly-organized body of men forms a most interesting chapter in the history of railroading, and it may prove of much value to other nations who have to use the railway as a civilizer. Not only was the construction of track over level country readily and cheaply accomplished, but such work as the erection of the bridge over the Oxus was executed in a satisfactory manner.

"A railway is a potent factor, not only towards occupying a country and aiding in its colonization, but also towards stimulating imports and exports if there is a native industry already in existence there.

"The wealth of the country beyond the Caspian lies in its cotton; the line was no sooner open than the Transcaspian railway began to bring in all the products which central Asia stands in need of, and to carry away towards the Caspian all the unmanufactured produce of the country.

"Russia imports cotton to the extent of 100 million roubles worth, and this used to come from America, Egypt, India, and central Asia. Of this, before the Transcaspian railway was built, only 800,000 roubles worth used to come from central Asia, but now half the cotton used in Russia comes from there.

"Accordingly the Transcaspian, which was built on military and political considerations, has led to an economic revolution, for it renders it possible for Russia to use a product coming from its own possessions instead of importing it from abroad."

On the plains where, during the Crimean campaign, the Tartars used to stop the advance of the Russian troops by setting fire to the standing grass, are now found populous and wealthy cities—many of them with a population exceeding 100,000. The same thing will happen in the steppes of central Asia and the Transcaspian district, but the railway will effect in a few years changes which in the other case took a hundred.

Compression in Steam Engines.

THE researches which have been made into the true action of the compression of steam in the clearance spaces of steam cylinders by Professor Dwelshauvers-Dery have been reviewed in these columns from time to time, and now we have to notice a further communication by him upon the same subject in the *Revue Universelle des Mines.*

The original trials conducted by Professor Dwelshauvers-Dery were made upon his experimental engine at the University of Liége, operating non-condensing, and the results appeared to prove that compression is not only of no benefit, but is, in fact, a source of loss. This result is so entirely opposed to what has been previously considered to be the case that the data of the tests have been examined and discussed by engineers in various countries, and Professor Boulvin of Ghent has especially attacked the conclusions as to the wastefulness of compression by endeavoring to show that the losses were really due to leakage, and that the theoretical investigations made by him demonstrated the truth of Zeuner's dictum that a compression of exhaust steam to the initial pressure nullified the injurious effect of clearance.

In order to meet these criticisms Professor Dwelshauvers-Dery has carried out a new series of trials, using the engine both condensing and non-condensing, and his discussion of the results of the later tests is now given to the public.

The data of the tests are examined very fully, using Hirn's analysis, and the results tabulated. The compression in these trials ranged from one-tenth to six-tenths of the stroke, the clearance and speed remaining constant.

The results fully confirmed the previous trials and, whether the engine was run with or without condensation, the experiments showed that the theory of the economy of compression was not borne out by the facts. Thus with one-tenth compression the steam consumption was 10.48 kilogrammes per horse power, with four-tenths compression 10.96 kilogrammes, and with six-tenths, 12.75 kilogrammes, there being an increase of 21.5 per cent. in the steam consumption between one-tenth and six-tenths compression.

A similar relation appears upon inspection of the indicator diagrams, it being plainly apparent that, after the compression attains a certain point, the pressure falls as the space diminishes, the effect of cylinder condensation being seen in the sudden hook formed at the end of the diagram.

This latest contribution to such an important question in steam economy will doubtless call forth further responses from those who hold contrary views.

In commenting upon this subject *The Engineer* calls attention to the fact that careful trials in the United States by Professor Jacobus show little or no variation in economy for varying degrees of compression, while other tests, both in America and in Germany, show gains with a moderate increase in compression.

Under these circumstances it is greatly to be desired that comparative tests by a number of skilled observers be made along the same lines as those adopted by Professor Dwelshauvers-Dery and that this important matter be settled upon a definite basis.

A Trans-Saharan Railway.

WHILE British industry and military prowess are united in clearing the way for a railway " from Cape to Cairo " there is being discussed in France a similar enterprise in another direction, and in the *Moniteur Industriel* is given an account of a proposed railway across the Sahara for the purpose of strengthening the French colonial possessions in Africa.

This important project had its origin more than twenty years ago, at which time it was considered solely from a commercial point of view; the great cost of the work, some 800 to 900 million francs, led at that time to its abandonment.

At the present time, however, other interests than those involved in commerce are to be considered and, in view of the growing strength of England in Africa, the construction of a railway crossing the desert of Sahara, and uniting the French colonies of Algeria and Tunis with the fertile country about Lake Tchad, is urged as a political and military necessity.

There is now a railway about 250 kilometres long from the port of Sfax, on the Mediterranean, to Gafsa, in the interior of Tunis, where a valuable deposit of phosphate rock is found, from which annual shipments of over 300,000 tons are now made. The general conditions of railway construction in this country are well-known, and it may be assumed without serious error that the prolongation of the Sfax-Gafsa railway across the desert could be made at about the same cost per mile as that portion already built. The climate is about the same, water is found at frequent intervals, and the topography does not greatly differ from that of the existing railway; It may therefore be estimated that the entire 2,000 kilometres could be completed at the cost of 60,000 francs per kilometre, including rolling stock, or a total of 120 million francs; and, even if this amount be increased by one-half to provide for unforeseen contingencies, it is yet far within the estimate of twenty years ago, which reached the enormous sum of over 800 million francs.

Apart from the strategical value of such a railway, there is some probability that its construction would have the effect of developing very materially the natural resources of the country through which it would pass. As a matter of fact, the real value of this portion of Africa is but imperfectly known. It is but a short time since the phosphate deposits of Algeria began to be worked, and even now, with proper transportation facilities, the present output of these beds could readily be increased to over a million tons per year. For some time there has been reason to believe that there exist in the interior of the Sahara important deposits of nitrates, which only need accesibility to rival those of Chile, and there are salt deposits already known to be awaiting development on the Soudan frontier.

These sources of traffic, however, are almost entirely in prospect; there is every reason to assume that the primary reason for the construction of a railway across the desert is that of extending, and at the same time consolidating, French power in Africa, and meeting the British colonial expansion in that continent by anticipating her in railway construction.

It is especially interesting to the engineer to note that in the attacks which are being made by nearly all the nations of Europe for permanent territorial hold in Africa, engineering work is depended upon as a more certain and enduring form of attack than military power, and that the railway, canal, and harbor are the real weapons in the conquest of a continent.

THE AMERICAN PRESS

Review of Leading Articles

The Mechanical Plant of Commercial Buildings.

AMONG the papers presented at the recent convention of the American Society of Mechanical Engineers that of Mr. W. H. Bryan, upon the mechanical plant of a modern commercial building, elicited much interesting discussion. It seems to be clearly recognized, in the United States at least, that such buildings are essentially engineering structures, in respect not only to questions of foundation, framework, and constructive details, but also to mechanical, steam, and electric plants, as well as plumbing and sanitary arrangements, all of these calling for engineering skill of the highest order.

In a modern American commercial building the mechanical plant is called upon to perform many important services, these being broadly included in the warming and ventilating, the lighting, and the transportation both of persons and merchandise.

This work involves the installation of a steam-power plant—including boilers, engines, piping, and transmission, together with provision for handling fuel and ashes—as well as a complete electrical plant, both for lighting and power. The transportation above referred to includes the operation of elevators, which, unless operated electrically, necessitate the installation of hydraulic power. All this machinery must, as a rule, be erected and operated in a much more contracted space than that which would be allotted to similar service in a manufacturing establishment.

The distribution of these various functions differs according to local conditions, and one of the most interesting portions of the discussion was that which was brought out by the practice of engineers from various parts of the United States.

In the southern States (the building discussed in the paper is in St. Louis, Mo.) the question of power is found to be the most important feature, while in New York and Boston the colder climate renders the warming of more consequence. In every case the lighting consumes a large portion of the electric current, while electric motors operate most of the machinery required.

Mr. Bryan divides the mechanical plant of a building into the following groups:

The steam boiler plant, including furnaces, brickwork, smoke flue, etc.

The elevator system, either hydraulic, electrical, or steam.

Dynamos and switchboard.

Steam engines for driving the dynamos.

Wiring, cables, arc and incandescent lamps, motors and fans for ventilating.

Steam-heating system, including the piping directly involved.

Large and high-pressure pipework including connections between boilers, engines, free exhaust, etc.

In order to avoid the controversies which frequently arise about the rated capacity of boilers based upon heating surface, Mr. Bryan adopts the plan of stating the quantity of steam required to generate the power, perform the heating, and meet the requirements generally, the weight of water per horse power being variously taken as 100 pounds per h. p.-hour, for the least economical pumps, etc., down to 28 pounds per h. p.-hour for compound engines driving dynamos, and an evaporation corresponding to the aggregate quantity of water thus computed being required of the boilers, leaving the responsibility of the proportion of heating-surface with the maker.

The low economy of steam or hydraulic elevators has become a matter of so general consideration that electric elevators were chosen; in this connection it is worthy of note that the cost of operation of the electric elevators ranges, as tests show, from one-half to one-third that of good hydraulic lifts, according to the economy of the pumps used for the latter.

Water-tube boilers, with so-called

"down-draught" furnaces, were installed, and, although no extraordinary evaporative results have been attained, the freedom from explosion, and the comparative absence of smoke-production, are desirable features which have been secured.

The remaining details of the plant described in Mr. Bryan's paper call for no especial comment, but the entire treatment of the subject, together with the animated discussion which followed, showed the important extent to which this branch of engineering occupies the practice of specialists.

In some architects' offices at the present time there are engineering members of the firm, the whole work, including both design and construction, being controlled in the office of the architect; but in by far the greater number of instances the service of special engineers is called in, and the work of the architect, for commercial buildings at least, is being more and more closely limited to questions of external appearance, both the structural work and the interior equipment being turned over entirely to the engineer.

Torpedo-Boat Destroyers.

AMONG the papers discussed at the recent meeting of the Society of Naval Architects and Marine Engineers was one by Mr. G. W. Dickie on the subject of torpedo-boat destroyers; it is worthy of especial attention, both by reason of the unsettled position of this class of craft since the experience with the Spanish destroyers, and because of Mr. Dickie's standing in the profession and the freedom with which he expresses himself.

The primary function of the destroyer is that of overtaking and destroying the torpedo boats of the enemy. Heretofore it has been assumed that this requirement was met by making the destroyer swifter and more heavily armed than the boat to be destroyed. Mr. Dickie, however, shows, in the first place, that there are other functions almost as essential as speed and armament, and, in the second place, that the recorded speeds of the boats to be destroyed are largely fictitious.

"A torpedo-boat destroyer must possess other qualities than those necessary for the destruction of torpedo-boats. In fact, the destroyer must be a sea-going vessel, able to remain at sea with the fleet to which she is attached, or to make independent voyages.

"The work of the torpedo-boat destroyer is to prevent the torpedo-boat attack, and is therefore performed in open water. She must keep the sea with the attacking fleet, watching every place of refuge for a torpedo boat. She must, therefore, possess speed equal to that of the torpedo-boat; a battery powerful enough to destroy her; sea-going qualities to enable her to keep a watch in spite of weather. She should be able to cover long distances at a high rate of speed and in stormy weather. The fleet to which she is attached should not be delayed and hampered by guarding her from harm; she ought, instead, to be able in all kinds of weather to act as a scout in advance of the fleet, keeping the larger vessels informed as to the whereabouts of a possible enemy. Such would be the ideal torpedo-boat destroyer."

If these requirements are to be met, much more substantial craft than the present destroyers must be built. On the Pacific coast especially—the waters Mr. Dickie had principally in mind—the distances to be traversed make thorough sea-going qualities imperative, and a destroyer capable of making the voyage to Honolulu from San Francisco at a speed of 15 knots, or to Puget Sound or San Diego at 20 knots, as he proposes, ought to be fit for any waters elsewhere on the globe.

Such a result, however, cannot at present be attained, if the weight and power be so proportioned as to make a maximum speed of 30 to 31 knots possible; so the destroyer proposed by Mr. Dickie, with a total load-displacement of 800 tons, and engines of 7,000 h. p., is intended to have a maximum speed of only 25 knots. This speed, however, is intended to be one which can be maintained for hours together, not only on trial, but at any time thereafter when it may be needed,—not as a mere spurt, but upon demand.

It is well known that torpedo boats, or, indeed, any other naval vessels, rarely equal their trial speed thereafter.

A large proportion of naval vessels rated at high speeds, especially those of a rate exceeding twenty knots, have obtained such speeds under conditions that cannot be reproduced when the speed is most needed, and a good, reliable, heavy-engined sixteen- or seventeen knot boat may outstrip them in a fight.

"Whatever speed a fighting ship has ought to be produced when ordered from the bridge. An Atlantic liner would not be considered a success if in ordinary weather she could not cross the ocean at very near her trial speed, and, if the machinery of a naval ship were as substantially built, she could do the same, if necessary, as long as her coal held out." That this can be done with naval vessels has been abundantly proved by the manner in which the Oregon practically equalled her trial speed at Santiago immediately after her long voyage around the Horn, and it may be of interest to remember that the Oregon was constructed in the yards of which Mr. Dickie is and was in charge.

Judging from the condition in which nearly all the torpedo boats of the United States navy were found after the brief service of the Spanish-American war, there seems to be little doubt that a destroyer built along the substantial lines indicated by Mr. Dickie would have no trouble in overhauling and disposing of any of them.

As Mr. Dickie himself says, the vessel which he proposes is "a sea-going torpedo-boat destroyer that can go to sea and remain at sea without any special risk, and at sea can maintain a speed of twenty-five knots for a few hours when such a speed is required; that can make extended voyages, thus serving the purpose of a scout or dispatch-boat, whenever or wherever such service is required; that carries a battery that makes her a torpedo boat destroyer in fact."

Such a boat would show better speed under regular service conditions than any of the so-called thirty-knot torpedo-boat destroyers, and, for seaworthiness, habitability, or fighting capacity, far outrank the best of them.

Electrolysis of the Brooklyn Bridge.

PERHAPS the most unexpected discovery made in connection with the great extension of overhead-conductor electric railways is that the return currents from the moving cars often seek buried metals, such as water and gas pipes, and, in more or less time, cause their destruction by electrolytic solution. The dangers to which buried pipes are thus subjected have caused the passage of strict municipal ordinances in the United States, and the matter has been made the subject of parliamentary regulation in the United Kingdom. So far, the injurious effects of these earth-currents have been investigated with reference only to pipes, but the well-established injury wrought upon these is beginning to cause fears for the safety of certain other subterranean metallic structures. In a long paper read before the last meeting of the American Institute of Electrical Engineers Mr. A. A. Knudson gives the results of a series of measurements of electrical potential between various rails and pipes in the borough of Manhattan, and concludes with some highly-interesting measurements of electrical pressures at various points of the New York and Brooklyn bridge. These show that, while the bridge is probably in no immediate danger, the electrical condition of the anchorages will bear watching.

The measurements of potential show that all over Manhattan island a slow destructive action is going on, embracing not only water and gas pipes, manholes, etc., but the vertical members of the elevated railway structure as well. It is demonstrated that the influence of an overhead-trolley line of only ordinary activity extends for more than a mile, and that the whole lower end of Manhattan island is permeated by earth-currents having their origin in the extended overhead-trolley system of Brooklyn. These currents seem to cross the East river by the bridge cables, and to ramify through the pipes, etc., beneath the surface of lower Manhattan, finding their way back to Brooklyn at a number of points along several miles of the river front.

The cables of the bridge are anchored to heavy cast-iron plates imbedded in masses of cut-stone masonry laid up with cement in the most substantial manner. The author concludes that, although these anchor plates are only a few feet above mean high-water-level, and some nine hundred feet back from the water-front on each side, there are no conditions present favorable to electrolytic action.

Just how this can be reconciled with the passage of a large current *via* the bridge from the Brooklyn side is not made clear. The fact that such a current does cross the river, and in sufficient amount to make itself evident over more than a square mile of the lower part of Manhattan, seems to be well demonstrated. Wherever the current leaves a metal in damp earth,—that is, where the metal is positive to the ground,—there will be electrolytic solution. The amount of this is definite, provided the conduction from the buried metal is electrolytic, and not due to the specific conductivity of the materials in which it is buried. As the bridge anchorages are bedded in a mass of stone and concrete, only a short distance away from salt water, and as both these substances are fair insulators, it is reasonable to assume that the only way in which the current can leave the anchor plates is by electrolytic conduction through such water and salts in solution as may be present.

Should this be the case, the metal parts of the anchorage will inevitably be dissolved, unless the electrolytic action is stopped. Unfortunately the anchorages are not accessible for examination, so that no theory of what is going on can be put to the test; but certain simple preventive measures might well be taken, and, whether or not the danger is real, would certainly have no harmful effect. Another conclusion which Mr. Knudson draws is that there is absolutely no perceptible outflow of current from the new conduit railway systems in New York. While this fact is not unexpected, it is gratifying to know that actual tests demonstrate that there can be no possible electrolytic action following the installation of a railway of this sort.

Architectural Acoustics.

THE acoustic properties of public auditoriums have as yet received but small attention in proportion to the importance of the subject, and in very many, if not most, cases architects appear to leave the matter entirely to chance. If a hall chances to develop good acoustic properties, it is considered a very fortunate occurrence, and, if not, some crude attempts may be made to improve matters, or the effort may be given up as hopeless.

A paper upon this subject, by Prof. W. C. Sabine, presented before the American Institute of Architects, and printed in full in the *Engineering Record*, contains a careful discussion of the problem in the light of the best information at present available, and, while it shows that the complexity of the subject renders a practical treatment extremely difficult, there are some important points a knowledge of which may be made of service in actual construction.

In the case of a speaker in the open air, the sound spreads in all directions; while there are no reflections or obstructions, much of the effect is wasted by the passage of the sound to points where there are no hearers. A wall placed behind the speaker will reflect a portion of the sound, and side walls and a ceiling will return still more. A portion of the sound will be reflected and a portion absorbed, according to the nature of the surface. When the distance and location of the reflecting surface are such that it will reinforce the sound to the audience, the material should be made as good a reflector as possible; but in many instances the sound returns only in time to make a confusing echo, in which case the surface from which it comes may be made absorbent.

Concerning the shape of the room, there are no positive rules which can be given, although certain general principles exist. " A wall immediately behind the speaker, angle walls cutting off the corners at each side, and a sloping ceiling, not high, immediately above him, are advantages. A curved ceiling over the audience, or one with sloping sides, is favorable." There is no advantage in the use of the ellipse or of any conic section with the speaker at the focus, and there is no simple geometrical surface ideal for the purpose, the many variables making the problem altogether too complex.

One of the difficulties in connection with the reinforcement of sound by reflection lies in the manner in which sound waves interfere with each other, the differences in the distances traversed by the waves reflected from various parts of the room causing the sound to be strengthened at some points and weakened at others. Professor Sabine shows how careful tests at the Harvard Physical Laboratory demonstrated the existence and nature of this action, but as yet no general cure for it has been devised, although in certain cases success has been obtained.

The principal feature in the problem, which has been treated in a practical manner, is that of the absorption of sound by surfaces from which reflection would be undesirable. In many cases, especially in empty, unfurnished rooms, the audibility of a sound will persist to such an extent as to interfere materially with the succeeding sounds. By the use of an electric chronograph it has been found possible to measure the rate of absorption of sound for a given room under various circumstances, and the influence of various kinds of hangings and upholstery can be very clearly shown. Similar effects are produced by the presence or absence of an audience, and, in order that the acoustic properties of a hall may be the same when only partially filled as when full, the vacant seats should be provided with cushions of equivalent absorbent value.

There are thus three factors in the problem,—loudness, interference, and distinctness; and the solution, like that of most other complex problems, must be a compromise. Interference is usually less noticeable than either deficient loudness or excessive residual sound. Residual sound can be reduced to the minimum by inclining the reflecting surfaces in such a manner as to bring all the sound by one reflection upon the audience, the latter being the most absorbent factor in a room. This will also raise the loudness to the maximum, both ends being thus attained together.

The principal difficulty lies in the fact that considerations of architectural design with regard to appearance must generally outweigh the desire for acoustic excellence; and, when æsthetic demands have been considered, and the requirements of lighting, heating, and ventilating fully met, the acoustic properties of a building have but small chance of consideration.

Professor Sabine's paper contains interesting details of tests and investigations of the acoustic properties of several buildings and rooms under various conditions, these probably being the first quantitative researches of this nature ever undertaken.

The Problem of the Gas Engine.

THE increasing interest which is being evinced in internal combustion motors is mainly based on the superior economy which it is thus possible to attain, but in spite of the demonstrated advantage in this respect the general introduction of gas or petroleum engines as substitutes for the steam engine does not appear to be imminent.

There are several reasons for this, and it is this phase of the subject which is discussed in a paper on the problem of the gas engine by Herbert L. Towle, in a recent number of the *American Machinist.*

The real problem of the gas engine lies in the peculiarly delicate conditions under which the combustion takes place, and it is not surprising that the equilibrium of these conditions should frequently be disturbed from causes which are not immediately apparent.

" We must remember that the cylinder is virtually a very small firebox with water cooled walls, that we have neither a bed of incandescent fuel, brick arch nor length of uptake, and that our gases are lighted and must burn themselves out from two to eight or ten times a second. The one thing, indeed, that renders these results possible is the compression which drives the vibrating molecules of gas and oxygen close together and preheats them before the spark or hot tube gives the quick additional impulse to their velocity, which makes them meet and unite.

"From these facts, well known to designers, two conclusions follow. The first is that the most immediate need of the gas engine is neither higher economy (though this is not to be disregarded), for it is already more economical than its competitors; nor lower price, for it is on sufficiently even terms in that respect at present; nor better mechanical design, for this is a matter only of experience and judgment on the part of the designer; and in respect of lubrication, balancing, valve gears and the like, the best engines of to-day leave little to be desired; nor is it even better regulation, for regulation as steady as desired can be obtained without unreasonable sacrifice of efficiency by throttling the charge or dividing the power; but what the gas engine requires to make it a serious factor in the commercial world is that the elements of uncertainty connected with its chemical operation be reduced to the utmost minimum or abolished altogether. Desirable in any case, this becomes a necessity when it is put in competition with its less fickle rivals. The second conclusion is that, to abolish this uncertainty, the conditions affecting combustion must be subjected to positive and automatic mechanical control, so that it shall be impossible for them to vary without actual and sensible derangement of working parts. In proportion as this is accomplished, and only in proportion, does mechanical certainty take the place of conjecture, and reliability become a question merely of the number, intricacy and durability of the several parts. To achieve this then may at present be considered the chief problem of the gas engine.

The Work of the Engineer.

THE annual address of the retiring president of the American Society of Mechanical Engineers, Mr. C. W. Hunt, discussing broadly the important subject of the work of the engineer, forms a very interesting contribution to the general literature of engineering, and some extracts from salient points will be of interest here.

After quoting from Tredgold's definition of the engineer, as one who is skilled in the application of the materials and forces of nature to the uses of man, Mr. Hunt goes on to differentiate between the two classes of engineers, *i. e.*, the engineer of the user and the engineer of the maker, comparing the manner in which one must superintend the construction of work which is to be performed according to specifications drawn up by the other. In this connection he compares the difference in the practice of the United States and other countries, American practice tending toward specifications of a very general character, leaving to the supplier the work of designing the particular means to accomplish the desired end.

The important advantages given to the work of the engineer by the progress which has been made in laboratory equipment, as well as the benefits due to scientific societies are noted, and the rapid advance in American productive and commercial interests are very clearly set forth.

"It has long been evident that we are making rapid progress in perfecting our manufacturing machinery, as well as organizing and developing our industries, thus constantly increasing the efficiency of our labor, until we have lately reached a point where an hour's labor with its facilities produced more of our principal products, and transported them farther, than an hour's labor would do in any other part of the world.

"The late war has revealed to us the fact that we have gone on reducing the cost of our products, and increasing our capacity for production, until our country alone does not furnish a sufficient market to insure steady work for our labor, and prosperity for our merchants and manufacturers. Like confined waters, the tendency of these economic forces has been to break out from their confinement and equalize trade conditions by seeking a market in the world outside. If articles which are necessary to supply the wants of man can actually be made with less labor and cheaper here than elsewhere, here they will surely be made, though it modify our traditional ideas of isolated position, and our protective theories. One hundred years ago the iron trade of Sweden was greater than that of England, and remembering the great changes which have taken place in the last hundred years, it would be rash to assume that the momentous economic changes which are now taking place, may not cause an equally great shifting of the centres of more than one phase of industrial activity."

The advent of the engineer into the work of daily life is noted as one of the features of modern conditions which indicate the transformation through which we are passing, and this is clearly shown to be a broad advance in general civilization.

From being a minor profession in the midst of many others of equal or superior influence, engineering has risen until it holds a place which commands practically the entire field of science and industry.

" Thus stands the engineer in the midst of a countless number of earnest explorers in the field of unrevealed nature, and so to speak, sees the tools forged and the materials discovered with which he is to work. Cheerfully can he enter upon his daily tasks with the consciousness that his application of these discoveries is of real service in lightening the burdens of life, as well as elevating and ennobling his fellow men."

The Fireproofing of Wood.

THE disastrous effects of the presence of a quantity of inflammable woodwork upon naval vessels in action was clearly shown by the manner in which the Spanish ships at Santiago were damaged by the combustion of their own material. With this experience in mind the United States bureau of construction has determined upon the use of fireproofed wood in the new battleships Maine, Missouri, and Ohio; and in a recent issue of *Engineering News* is given an account of the method of preparing the wood to be used on these vessels.

The general process resembles very much that of creosoting timber to preserve it from decay, the creosote being replaced by a solution consisting principally of phosphate of ammonia and sulphate of ammonia. As in the case of creosoting, the principal object to be attained is that of introducing the solution very thoroughly into the pores and channels of the wood. This is best accomplished by first opening the pores and replacing the natural juices with moisture, and then removing the moisture by evaporation.

The presence of steam at too high a temperature is apt to reduce the strength of the wood, and at the same time to seal the pores, thus defeating the object in view; but, if the timbers are placed in a closed cylinder, containing a few inches of water at the bottom, and low-pressure steam is introduced, it is found that the pores of the wood will be opened almost like those of a sponge, and the best possible preparation made for the reception of a foreign solution.

After the wood is thoroughly saturated with moisture, the second stage—that of evaporation—is begun by gradually inducing a vacuum in the cylinder, and thus exhausting the moisture from the pores of the wood, leaving them open for the entrance of the fireproofing liquid. The vacuum is broken about every three hours, to permit the accumulated moisture to be drawn off, and, after all the moisture has been removed, a final vacuum of twenty to twenty-eight inches is maintained, while the fireproofing solution is caused to fill the cylinder. To insure a complete filling of the pores of the wood, a pressure is applied to the liquid in the cylinder, and maintained until the wood is fully saturated.

The final process is that of drying the treated lumber, which solidifies the chemicals in the pores and leaves the wood in a condition for use. This drying should be performed at a moderate temperature, in order to avoid injuring the wood for constructive purposes, too high a temperature rendering it weak and brittle; in practice, a kiln temperature of 85° to 125° F. has been found suitable.

Tests have shown the strength of wood thus treated to be but slightly impaired, and, while it may be too much to say that it is entirely fireproof, yet it may justly be claimed that it is non-inflammable. When it is exposed to flame, it will char, and, if the flame be continued, it will be completely carbonized, but it will not catch fire, and, when the source of heat is removed, it will not retain the flame. This is undoubtedly in conformity with the requirement of the United States navy department, which is that, "when dry and subjected to heat of 600° F., it will remain non-inflammable, and absolutely safe against spread of fire from point of contact."

Deflections of Railway Bridges.

THERE exists, among engineers, a wide difference of opinion as to the provision that should be made for the stresses due to moving loads on railway bridges, and as to how the allowance should be distributed among the different members of the bridge. In some specifications the element of fatigue of metals is considered, while in others the live load stresses are increased a certain percentage "for impact" and then treated as dead load stresses. Still other specifications take account of both fatigue and impact.

It seems logical that both fatigue and impact should be provided for if both exist, but before a formula can be deduced the two must be considered separately.

With the hope of contributing something to the solution of this problem, Mr. F. E. Turneaure conducted, during the summer of 1897, a most elaborate series of experiments on bridges of varying span, type and design, and embodied the results in a valuable paper before the American Society of Civil Engineers.

Two instruments were used, one for measuring and automatically plotting the deflection of the span, the other for similarly registering the extension of individual members under strain. Both are the invention of Professor Fraenkel, of Dresden, and consist of chronograph cylinders turned by clockwork under a pencil point arranged to greatly multiply the respective movements of extension and deflection. About three feet of the tension member under examination were embraced by the extensometer, while a steel wire, attached to a heavy weight on the ground below the span and kept taut, furnished the base for the indications of the deflection register.

Tests were made on twelve plate-girder bridges of spans varying from 25 to 80 feet, and eleven truss bridges of spans from 100 to 200 feet, on the Chicago, Milwaukee and St. Paul and Union Pacific railways. About 400 experiments in all were made, mostly with trains of the regular traffic, though a few were conducted with trains of light and loaded cars.

The results of the experiments are presented by the author in graphic form and with a great wealth of interesting detail. The conclusions drawn may be briefly summarized as follows:

Much vibration is not likely to result from speeds less than about 25 miles per hour. The increase in deflection, caused by locomotives running at speeds of 40 to 50 miles per hour, is likely to be 40 to 50 per cent. for girder spans of less than 50 feet length, but this percentage decreases rapidly for longer spans, becoming about 25 per cent. as a maximum for 75 foot spans. Owing, however, to cumulative effects, the percentage is likely to be a maximum of 20 to 25 per cent. for spans of 75 to 150 feet, or more, but the experiments indicate no increase of percentage for increase in span.

Chord stress is increased in about the same proportion as deflection, that in the center diagonal being somewhat larger, while in the hip vertical it corresponds more nearly to the deflection in short girder spans.

In the spans tested the effect of the speed of application of the load on the mean deflection was inappreciable (the increase in deflection from moving load being due to vibration) though theory points to an appreciable increase from this cause in short spans without camber.

In small girders with shelf-angles, and in some parts of trusses, secondary stresses are likely to be high. The discrepancy between the computed and observed stresses may actually be greater from this cause than from the dynamic effect of moving loads.

THE ENGINEERING INDEX

INTRODUCTORY

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m* a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill=Illustrated; W=Words; Anon=Anonymous.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Jour. *m.* London.
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg-und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am. Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S.A.R,
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, New York.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York.

Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, O.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs. and Surveyors. Peoria, Ill.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour N. E. Waterw. Assoc. *qr.* New London, Conn.
Journal Political Economy. *qr.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kans.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London.
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.

Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *qr.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines, *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerische Bauzeitung. *w.* Zürich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York.
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club. Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Locomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Architectural Engineering.

General Practice in Regard to the Employment of Electrical, Heating and Sanitary Engineers. H. G. Bradlee. Read before the convention of the Am. Inst. of Archts. Discusses the mutual relations of architects and engineers, presenting both sides of the question, and offering suggestions to overcome difficulties. 7000 w. Am Arch—Nov. 12, 1898. No. 23930.

Building Details.

Balanced Column Loads. Illustrated description of steel construction in an 8 story warehouse. 1200 w. Eng Rec—Nov. 26, 1898. No. 24225.

Bungalows.

Indian Bungalows. Plans of typical bungalows, describing and pointing out defects in arrangement, insanitary conditions, &c. 3800 w. Ind & East Engr—Oct., 1898. No. 24014 D.

Competition.

Report on the "Shattuck Prize" Competition for Artisans' Houses. The housing of fifty artisan households in the suburbs of a city was the subject of study. The designs presented are illustrated and discussed. 3000 w. Am Arch—Nov. 26, 1898. No. 24262.

Corfu.

Dwelling Houses in the Island of Corfu. (Wohnhäuser auf der Insel Korfu.) A. Meissner. A description of the island, and some accounts of the characteristic features of the local architecture. 1500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Nov., 1898. No. 24123 D.

Design.

The "Bases of Design." Walter Crane. A review of this book with some of the most valuable points noted. 2300 w. Arch Rev—Vol. V, No. VII. No. 23844 F.

Domes.

The Theory of Construction of Domes and Spires. (Beitrag zur Theorie der Kuppel und Turndächer und Verwandter Konstruktionen.) H. Müller-Breslau. A very full theoretical and practical discussion of the structural work of domes, cupolas, gasholders and spires, with diagrams and photographs of structures. Two articles. 1200 w. Zeitschr d Ver Deutscher Ing—Oct. 29, Nov. 5, 1898. No. 24107 each D.

Fire-Proof Construction.

An Example of Fire-proof Church Architecture. Peter B. Wight. An illustrated description of the new St. Paul's (R. C.) church in Chicago, with interesting facts relating to its construction. 2300 w. Br Build—Nov., 1898. No. 24260 C.

Fire-Resisting Floors. Frederick R. Farrow. Extracted from a paper issued by the British Fire Prevention Committee, and published in the *Railway Engineer*. Reviews the earliest attempts at the construction of these floors, and describes various forms which have been devised. Ill. 1800 w. Ry & Eng Rev—Nov. 26, 1898. No. 24266.

Special Fireproof Construction in the U. S. Appraisers' Warehouse, New York City. Gunwald Aus. Illustrated description of this large building, with special mention of the fire-retarding screen which encloses the light well. 1000 w. Eng News—Nov. 3, 1898. No. 23772.

Floors.

Ceramic Mosaic v. Marble Pavement. H. C. Mueller. Setting forth the possibilities of burnt clay for flooring. 600 w. Br Build—Nov., 1898. No. 24261 C.

Foundations.

Chicago Post Office Foundations. Review of paper by William Sooysmith on the remarkable long-pile foundations of a 300x360 ft. building. Each pile carries 30 tons. 3600 w. Eng Rec—Nov. 26, 1898. No. 24219.

The Foundations for the U. S. Government Post Office and Custom House Building at Chicago. William Sooysmith. Gives a statement of the kinds of materials met with in constructing these foundations, and an illustrated description of the work. 4000 w. Jour W Soc of Engs—Oct., 1898. No. 23917 D.

Native Architecture.

Native Architecture in Africa and New Mexico. Illustrated description showing that similar conditions have caused a great similarity in the native architecture of these remote regions. 2000 w. Sci Am—Nov. 12, 1898. No. 23893.

Observatory.

The Observatory of Paris. J. Guénaire. Illustrated historical account, with some reference to the important work carried on. 2000 w. Sci Am—Nov. 19, 1898. No. 23973.

Opera House.

The Paris Opera House. Description, with illustrations, of the most remarkable modern edifice in France. 1400 w. Sci Am Sup—Nov. 12, 1898. No. 23895.

Oxford.

The Buildings at Oxford, From an Engineer's Point of View. J. W. Parry. An exceedingly interesting illustrated description of the ancient buildings of the various colleges of Oxford, with many curious details of construction methods, showing the expedients of architects and engineers before the invention of many of the present building methods and materials. 5000 w. Engineering Magazine—Dec., 1898. No. 24287 B.

Roman Construction.

Roman Construction. G. W. Percy. Describes and illustrates methods employed by Roman builders in constructing vaults and arches. Discussion. 4500 w. Jour Assn of Engng Soc's—Oct., 1898. No. 23979 C.

HEATING AND VENTILATION.

Bank Building.

Ventilation and Heating of a Syracuse Bank Building. Illustrated description of the combined direct and indirect heating plant in a 10-story building with special ventilation for the banking rooms. 1500 w. Eng Rec—Nov. 5, 1898. No. 23798.

Heating Surface.

Concentrated Heating Surface for Hot-Blast Systems. J. H. Kinealy. Describes the two general systems of arranging the heating surface of hot blast apparatus, and comments on cost and advantages. 1000 w. Heat & Ven—Nov. 15, 1898. No. 24083.

Hospitals.

The Ventilation, Heating, Water Supply and Drainage of Infectious Diseases Hospitals. E. R. Matthews. Read at meeting of Inst. of San. Engs. (England). Reviews the origin of these hospitals in England, mentioning important points in selecting a site, describing general structural arrangements, and precautions necessary in the lines mentioned. 2000 w. San Rec—Nov. 4, 1898. Serial. 1st part. No. 23956 A.

Hot-Water Apparatus.

The Dangers of Hot-Water Heating Apparatus. Gives especial attention to dangers arising from frost, illustrating by examples. 3300 w. Builder—Oct. 29, 1898. No. 23-852 A.

Hot-Water Pipe.

English Views on the Cause of Noises in Hot-Water Pipe. Refers to hot-water apparatus which supplies baths and taps from a boiler in a kitchen range. 2800 w. San Plumb—Nov. 1, 1898. No. 23873.

Ohio University.

The Heating, Ventilating and Power System of Ohio State University. A. E. Hitchcock. A satisfactory solution of heating widely separated buildings, and for supplying power at any point, at small cost. Ill. 1500 w. Heat & Ven—Nov. 15, 1898. No. 24082.

School.

Heating the School at Pocantico Hills, N. Y. Illustrated description of the heating arrangements in a building consisting of one story and basement. 1100 w. Met Work—Nov. 12, 1898. No. 23908.

Station Heating.

Arrangement and Ventilation of the Providence Union Station. This station, one of the largest in the United States, is the result of 20 years' study. It comprises several detached buildings heated from a central plant, and its mechanical plant is illustrated. 2000 w. Eng Rec—Nov. 12, 1898. No. 23925.

Steam.

High-Pressure Steam Heating Plant. (Hochdruck Dampfheizungsanlagen.) H. Menz. Discussing especially the methods and devices for returning the water of condensation back to the boiler in high-pressure steam heating installations. 2500 w. Gesundheits-Ingenieur—Oct. 15, 1898. No. 24125 B.

Subway Ventilation.

Ventilation of the Boston Subway. Description of a plant with electrically driven fans which change the air in the subway every 15 minutes. 600 w. Eng Rec—Nov. 19, 1898. No. 24024.

Ventilators.

The Computation of Screw Ventilators. (Ueber Berechnung der Schraubenventilatoren.) A paper by Herr Recknagel upon the computation of the discharge of ventilating fans of the screw disk type, giving formulas and application; also discussion. 2500 w. Gesundheits-Ingenieur—Oct. 15, 1898. No. 24127 B.

See Electrical Engineering, Heating and Welding.

PLUMBING AND GASFITTING.

Drainage.

The Effect of Recent Decisions on the Liabilities and Rights of Owners in Respect of the Drainage of Buildings. Alexander Macmorrow. Paper read at a meeting of the Auctioneers' Inst., England. Calls attention to important points that have been the subjects of recent decisions, showing what the British law requires. 2500 w. San Rec—Nov. 11, 1898. Serial. 1st part. No. 24038 A.

MISCELLANY.

Acoustics.

Architectural Acoustics. Illustrated paper, by W. C. Sabine, on the acoustic properties of auditoriums, and experiments made at Harvard University to determine methods of overcoming defective acoustics in halls. 4000 w. Eng Rec—Nov. 12, 1898. No. 23926.

Address.

The Advancement of Architecture. George Aitchison. Presidential address before the Roy. Inst. of Brit. Arch'ts. Considers the need of proper teaching to advance architecture. Discusses some of the points requiring study, and the subject generally. 5000 w. Brit Arch'ts—Nov. 11, 1898. No. 24036 A.

Architects.

The New Architect: His Work and Registration. Howard Pentland. Inaugural address to the Archt. Assn. of Ireland. Considers present architectural practice, and the necessary training of architects, comparing the work with that required at earlier periods. 5700 w. Builder—Nov. 5, 1898. No. 23961 A.

Architectural Engineering.

The Employment of Consulting Engineers by Architects. Abstract of paper by H. G. Bradlee, before the Am. Inst. of Arch'ts. 1500 w. Eng Rec—Nov. 5, 1898. No. 23797.

Cathedral.

Glasgow Cathedral. William J. Anderson. Review of a book recently edited by George Eyre Todd, giving the history and an illustrated account of the greatest fane of Scotland. 3000 w. Jour Roy Inst of Brit Arch'ts—Oct. 15, 1898. No. 23830 B.

Criticism.

Criticism Which Helps. C. H. Blackall. The relation of criticism to architecture, the importance in encouraging artistic growth, &c., with editorial comment. 4000 w. Arch Rev—Vol. V, No. VII. No. 23843 F.

Decoration.

Interior Decoration. W. H. Elliott. Considers some points essential to successful wall decoration. 1000 w. Can Arch—Nov., 1898. No. 23991 C.

Excavations.

Excavations in Thebes. John E. Newberry. Read at meeting of the Archt. Assn., London. Contains a description of the architecture and details of the Temple of Hatshepsut, now known as Deir-el-Bahari, with account of the work of excavating. 9000 w. Arch, Lond—Nov. 4, 1898. No 23957 A.

Forms.

Architectural Forms in Nature. F. S. Dellenbaugh. Interesting illustrated description of natural contours resembling buildings, bridges and other architectural structures. 3300 w. Ap Pop Sci M—Nov., 1898. No. 23721 D.

Modern Decoration.

Notes and Queries on Modern Decorative Design and Color. Alexander Rottman. Read at meeting of the Nat. Assn. of Master House Painters. Discusses British practice. 4500 w. Plumb & Dec—Nov. 1, 1898. No. 23897 A.

Obelisks.

How Did the Egyptians Raise their Obelisks? (Comment les Égyptiens ont-ils Érigé leurs Obélisques?). Short illustrated abstract of an article on this subject in *Construction Moderne* by J. C. Kruseman. 700 w. Le Génie Civil—Oct. 29, 1898. No. 24160 D.

Parthenon.

The Parthenon Marbles. Abstracts of a course of lectures given in the Alexandra School, Dublin, by Miss J. E. Harrison. Reviews the modern history of these marbles, and studies the Ionic frieze, the marbles that decorated the pediments, &c. 4500 w. Arch, Lond—Nov. 11, 1898. Serial. 1st part. No. 24041 A.

Steel Specifications.

Specifications for Structural Steel. Suggestions for their improvement. 900 w. Eng Rec—Nov. 26, 1898. No. 24215.

Tenements.

The Housing of the Poor. Abstract of address by the Lord Mayor of Dublin, showing that the condition of the very poor is also of immense importance to all classes. 2000 w. San Rec—Oct. 28, 1898. No. 23817 A.

Varnishes.

Varnishes, &c., Used in Building Structures, by Wood Workers, &c. The treatment of the various kinds of wood, and the composition of the varnish to be used. 4500 w. Builder—Oct. 29, 1898. No. 23853 A.

Venetian Palaces.

Some Palaces on the Grand Canal. C. T. Mathews. Part first gives an illustrated historical account of the Doges' Palace. 2400 w. Am Arch—Nov. 5, 1898. Serial. 1st part. No. 23840.

Wood.

Some Peculiarities of Wood. B. E. Fernow. Read at the convention of the Am. Inst. of Arch'ts. Comments on the small amount of knowledge concerning the nature, characteristics and properties of wood, and the wastefulness in consequence. Discusses the advantages and disadvantages as a material, &c. 3400 w. Am Arch—Nov. 19, 1898. No. 24034.

CIVIL ENGINEERING.

BRIDGES.

Bridge Erection.

Bridge Erection by Projection. Describes the erection of a number of bridges in this manner. 1000 w. Eng Rec—Nov. 19, 1898. No. 24021.

Buckling.

The Buckling of the Trusses of the New York and Brooklyn Bridge. F. Collingwood. An illustrated account of the circumstances which caused the buckling of the lower chords of the trusses in July last, with editorial comment. 3000 w. R R Gaz—Nov. 18, 1898. No. 24006.

The Management of the Brooklyn Bridge. Review of article by F. Collingwood on the stresses in the Brooklyn Bridge and the buckling of chord members of the stiffening trusses. 1700 w. Eng Rec—Nov. 26, 1898. No. 24216.

Ship Canals.

See Economics and Industry, Commerce.

Elbe.

The New Railway Bridge over the Elbe at Lobositz. (Die Neue Eisenbahnbrücke über die Elbe bei Lobositz.) H. Rosche. With view of the completed bridge, and plan of railway connections. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 28, 1898. No. 24116 B.

Japanese Bridge.

A Japanese Bridge. Drawing and brief description of a quaint, strong and handsome wooden bridge at Iwakuni, Japan. 250 w. R R Gaz—Nov. 11, 1898. No. 23902.

Loads.

Some Experiments on Bridges under Moving Train-Loads. F. E. Turneaure. Description of a series of experiments on bridges of varying span and design, giving results of tests, with description of apparatus used, and a discussion of the points involved. Ill. Pro of Am Soc of Civ Engs—Nov, 1898. No. 24232 F.

Melan Arch.

Two Recent Melan Arch Bridges. Illustrates and describes two bridges erected on the private estate of Mr. Frederick W. Vanderbilt at Hyde-Park-on-the-Hudson. 800 w. Eng News—Nov. 10, 1898. No. 23882.

Stresses.

Fatigue Formulas in Bridge Specifications. Editorial review of new bridge specifications, recognizing the fatigue of metals, with full abstract of paper by H. B. Seaman. 4000 w. Eng Rec—Nov. 5, 1898. No. 23792.

Safe Working Stresses. R. H. Thurston. Discussion of Mr. Stone's paper read at the July meeting of A. S. C. E. Reviews the knowledge that has been gained by experience and experiments, and discusses many points bearing on this subject. 3700 w. Sib Jour of Engng—Nov., 1898. No. 23987 C.

Working Stresses for Railroad Bridges. Brief abstract of a paper on railroad bridge specifications, by H. B. Seaman, with editorial discussion. 2500 w. R R Gaz—Nov. 4, 1898. No. 23783.

Suspension.

Old and New Forms of the Suspension Bridge. Gustav Lindenthal. A well-illustrated history of the suspension bridge with descriptions of the most notable examples. The difficulties of construction and engineering problems solved in former bridges are discussed, and a full description of the proposed Hudson River bridge at New York is given. 4000 w. Engineering Magazine—Dec., 1898. No. 24284 B.

The Covington and Cincinnati Suspension Bridge. Illustrated description of the construction of the new cables. 2200 w. Eng Rec—Nov. 26, 1898. Serial. 1st part. No. 24217.

CANALS, RIVERS AND HARBORS.

Alaska.

Surveys of the Gateways to Alaska. An account of the work done in mapping the delta of the Yukon and other operations of the coast survey. 900 w. Science—Nov. 18, 1898. No. 24012.

Antwerp.

The Quay Wall at Antwerp. Illustrated description of a very heavy wall of concrete blocks each having a pneumatic foundation. 1000 w. Eng Rec—Nov. 26, 1898. No. 24218.

Bohemia.

The Status of the Canal Work on the Moldau and Elbe in Bohemia. (Ueber den Stand der Canalisierungsarbeiten an der Moldau und Elbe in Böhmen.) An official illustrated report upon these important river improvements which form a part of the great internal water-ways system now being developed in Germany. 3000 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—Nov., 1898. No. 24122 D.

Cableways.

Cableway at Lock and Dam No. 2. Mississippi River Improvement. R. D. Seymour. Illustrates and describes a cableway showing decided improvement in construction and manner of operation. Also discussion. 5000 w. Jour W Soc of Engs—Oct., 1898. No. 23915 D.

Canal Operation.

The Efficiency and Cost of Operation of Canals. (Leistungsähigkeit und Betriebskosten der Canäle.) J. Deutsch. A long discussion of the relative advantages of inclined planes and locks for canals, and containing much useful information concerning the operation of internal waterways. 10,000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 14, 1898. No. 24113 B.

Canal Transportation.

The Passing of the Canal. Editorial on the reasons why river and canal transportation in the United States has been gradually abandoned, and why railways have superseded water routes. 2200 w. Eng News—Nov. 24, 1898. No. 24203.

Dam.

An Unusual Small Masonry Dam. Irving Righter. Illustrated description of an arched dam of cut stone. 800 w. Eng Rec—Nov. 26, 1898. No. 24220.

The Dam at La Bourbonée. (Le Barrage de La Bourbonée.) Detailed description of a masonry dam of medium size, with an illustration and a plate of details. 1500 w. La Rev Tech—Oct. 25, 1898. No. 24167 D.

Dredges.

Dredges on the Mississippi. (Die Bagger auf dem Mississippi.) R. Wels. A very full review of the Government work upon the Mississippi, with many illustrations of suction and bucket dredges, based on various official and professional reports. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 22, 1898. No. 24104 D.

Mississippi.

Improvement of the Mississippi River Delta. Thomas L. Raymond. Briefly reviews methods tried in the past, and describes the jetty system, the only successful plan found. 4400 w. Jour Assn of Engng Soc's—Oct., 1898. No. 23980 C.

New York Canals.

Canal Work Well Done. Abstract of statement of George W. Aldridge, with editorial comment. 7000 w. Sea—Nov. 3, 1898. No. 23782.

The Reply of State Engineer Adams to the Canal Investigating Commission. Abstracts of replies of the State engineer and Supt. of Public Works, with editorial comment. 5500 w. Eng News—Nov. 3, 1898. No. 23773.

Steel Aqueduct.

Steel Canal Aqueduct at Briare, France. Information from paper of Mr. Mazoyer, in *Annales des Ponts et Chaussées*. Illustrated description of interesting features of this engineering work, built to connect the Loire and Briare canals across the river Loire, near the town of Briare, France. 600 w. Eng News—Nov. 3, 1898. No. 23774.

Surveying.

Hydrographic Surveying in Nicaragua. Francis W. Belknap. A description of the methods employed by the Walker Board on the east interoceanic-canal investigation. 4000 w. Eng Rec—Nov. 19, 1898. No. 24019.

IRRIGATION.

Anicut.

Lower Coleroon Anicut. An account of the proposed improvements and their cost. 1200 w. Ind Engng—Sept. 24, 1898. No. 23714 D.

Egypt.

Public Works in Egypt. Summary of report for 1897, of Sir W. E. Garstin, Under Secretary for Public Works, upon the Irrigation Dept. Briefly reports the increase in the chief crops, and gives information of drainage works and other improvements. 1600 w. Arch, Lond—Nov. 11, 1898. No. 24040 A.

Irrigation Works.

Kuan Hsien Irrigation Works. Description of one of the oldest irrigation works in the world taken from a report of a journey made by S. J. L. Litton to North Ssu-ch'uan. 1200 w. Engr, Lond—Oct. 21, 1898. No. 23724 A.

Cement.

German Tests of Cement. Replies from a German point of view, to the questions issued by the Am. Soc. of Civ. Engs. Translated from the *Baumaterialienkunde*. 2200 w. Arch, Lond—Oct. 28, 1898. No. 23854 A.

History of the Portland Cement Industry in the United States. Robert W. Lesley. A brief account of the development from its inception, showing that the industry owes much to the application of American methods and processes; discussing also the methods in use in the United States and in Europe. Discussion. 6500 w. Jour Fr Inst—Nov., 1898. No. 23826 D.

Influence of Sulphate of Lime on the Hardening and Adhesion of Cements. (Influence du Sulfate de Chaux Contenu dans les Ciments sur le Durcissement et la Tenue les Bétons et Mortiers.) An abstract and review of recent work of M. Vialler on this subject. 1900 w. Le Génie Civil—Nov. 5, 1898. No. 24164 D.

Notes on Hydraulic Cement. A. W. Hale. Report of experiments to determine the percolation. 1400 w. Eng & Min Jour—Nov. 5, 1898. No. 23801.

Western Portland Cement Company's Plant, Yankton, S. D. Frederick H. Lewis. Illustrated description of works using chalk and clay and following the general scheme of English works on the Thames and Medway, with the exception of the methods of working the slurry. 1600 w. Eng Rec—Nov. 19, 1898. No. 24018.

Colorado.

Notes of an Engineer in Colorado. W. P. H. A letter containing information of interest about the railroads, mines, water-works, and other engineering works in the vicinity of Leadville. 4200 w. Eng News—Nov. 24, 1898. No. 24204.

Concrete Facing.

Concrete Facing on a Sandstone Bluff at St. Paul, Minn. Onward Bates. Describes the conditions and the reasons for using a concrete facing instead of cut-stone masonry, giving illustrated account of the work. 2000 w. Jour W Soc of Engs—Oct., 1898. No. 23916 D.

Contracts.

Extra Payments on Contracts. The opinion of the Utah Supreme Court on a contract requiring more work of certain classes than called for in the engineer's estimate. 1200 w. Eng Rec—Nov. 12, 1898. No. 23920.

Engineering Education.

Mr. W. H. Preece on Technical Education. Reply to an assertion by the President of the British Inst. of Civ. Engs., that professors in technical schools are arrogant and behind the age. 1200 w. Eng Rec—Nov. 19, 1898. No. 24016.

Forestry.

National Instruction in Forestry. A statement of the new method of the U. S. Agricultural Department to teach the management of woods and forests. 800 w. Eng Rec—Nov. 5, 1898. No. 23794.

Re-enforced Cement.

Re-enforced Cement Constructions. (Constructions en Ciment Armé.) Gérard Lavergne. A well illustrated general review of the subject of constructions in concrete with imbedded metals. The first part gives a general description of six systems. Serial. Part 1. 1700 w. Le Génie Civil—Nov. 12, 1898. No. 24186 D.

Roads.

Road Building. An informal discussion by T. H. McCann, F. G. Cudworth, and M. D. Burke. 3300 w. Pro of Am Soc of Civ Engs—Nov., 1898. No. 24233 F.

Surveying.

A Trial at the Revision of the Survey System of France. (Un Essai de Réfection Intégrale du Cadastre.) Gérard Lavergne. A very full illustrated description of methods and instruments used in the survey of the commune of Neuilly-Plaisance, with reference to their application to a general resurvey of France. 3600 w. Le Génie Civil—Nov. 5, 1898. No. 24163 D.

Tunnelling.

Experience with Compressed Air Tunnelling. Abstract of a paper by George Henry Dunlop, read before the Victorian Inst. of Engs. at Melbourne, giving the writer's experience with hydraulic shield tunneling in connection with sewerage and other work, and referring to the relative advantages and disadvantages of each system. 4000 w. Engng—Nov. 11, 1898. No. 24070 A.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Agricultural Implements.

The Trade with Argentine in Agricultural Implements. Statistics of the exportation of iron and steel and manufactures of these products, showing that America supplies more than half the agricultural machinery, and discussing means of increasing the trade. 1200 w. Am Mfr & Ir Wld—Nov. 11, 1898. No. 23934.

American Coal.

American Coal in Foreign Countries. Articles from the *London Morning Leader*, and from the British *Coal and Iron Trades Review*, on the posssibilities of American coal competition. 1500 w. U. S. Cons Repts—Nov., 1898. No. 23811 D.

American Iron.

The American Iron and Steel Industries in 1897. Perry F. Nursey. A general review of the iron and steel trades as represented in the latest annual report of the Am. Ir. & St. Assn. 2500 w. Ind & Ir—Nov. 11, 1898. Serial. 1st part. No. 24051 A.

Brazil.

Resources of Brazil. An article on the economic condition of Brazil, written by L. Lipman, a well-informed local authority. Also a translation of the advertisement for coal for the Brazilian Central Railroad. 3300 w. U. S. Cons Repts—Nov., 1898. No. 23810 D.

British Trading.

British Trading Methods. Editorial on the charges brought against the British trader. 1700 w. Engng—Oct. 21, 1898. No. 23735 A.

China.

Chinese Railroad Development, Past, Present, and Future. Charles Denby and E. P. Allen. This interesting paper reviews the railway situation in China and gives the grounds for the popular objections to railway building in that country. Routes are described and the problem of conflicting claims by European nations discussed. It concludes with a review of present Chinese politics and describes the vast market for engineering products in the Orient. 4500 w. The Engineering Magazine—Dec., 1898. No. 24282 B.

New Conditions of Trade in China. Notes some of the changes taking place so rapidly in China, and their effect on trade. 1000 w. U. S. Cons Repts—Nov., 1898. No. 23815 D.

Trade of Amoy and Formosa. Editorial on the importance of looking after the interests of old ports as well as endeavoring to obtain a foothold in new ones, and giving particulars relating to the trade of the ports mentioned. 1300 w. Engng—Oct. 21, 1898. No. 23736 A.

Collection.

Southern Collection Laws. C. J. Haden. Showing that the collection laws of the Southern States do not meet the requirements of rapid commerce. Gives an analysis of their operation in relation to outside creditors. 2400 w. Mfrs Rec—Nov. 4, 1898. No. 23761.

Competition.

American Competition. Editorial on the annual report of the Am. Ir. & St. Assn. 2000 w. Engng—Nov. 11, 1898. No. 24069 A.

Egypt.

The Commercial Development of Egypt. Editorial directing attention to points connected with the recent industrial and commercial development, based mainly on a report by the U. S. agent and consul-general at Cairo. 1800 w. Engng—Nov. 11, 1898. No. 24068 A.

Exports.

Immense Export Trade Totals. Calls attention to features in the report for October which deserve notice ; the value was the heaviest ever reported for that month, and second only to the total for Dec., 1897. 800 w. Bradstreet's—Nov. 19, 1898. No. 24025.

Free Trade.

England's Future Policy. A discussion of the free trade doctrine and the state of affairs that has been gradually developing during the last fifteen years. 3000 w. Gunton's Mag—Nov., 1898. No. 23806 C.

Greece.

United States Trade with Greece. A valuable report from the consular agent at Piraeus, in view of the movement to secure a direct line of steamships from the United States to the eastern Mediterranean ports. 1500 w. U. S. Cons Repts—Nov., 1898. No. 23812 D.

Interstate Commerce.

The Powers of the Interstate Commerce Commission. Charles A. Prouty. Discusses proposed legislation and the attitude of prominent railroad men, stating what the commission has asked in respect to rates. 6800 w. N Am Rev—Nov., 1898. No. 23776 D.

Iron and Steel.

United States Trade in Iron and Steel with the Netherlands. Report of the trade based on Dutch statistics. 1600 w. Am Mfr & Ir Wld—Nov. 25, 1898. No. 24264.

Mineral Traffic.

Mineral Traffic on Railways in 1897. Report for the United Kingdom, showing the progress as compared with 1896. 800 w. Col Guard—Nov. 18, 1898. No. 24278 A.

Ship Canals.

Equipment, Management, and Economic Influence of the Ship Canal. W. Henry Hunter. Takes the ground that engineering is applied economics, and discusses the subject from this broad standpoint. It describes the necessary terminal docks, railway connections, wharves, cranes and tackles, storage docks and warehouses, and extols the benefit to be derived from the construction of these waterways. Serial. 1st part. 4000 w. Engineering Magazine—Dec., 1898. No. 24283 B.

Shipping.

Shipping Rings. Editorial on facts brought out in the paper by John R. Galloway, read in the Economic Science section at the Bristol meeting of the British Assn. Discussing the bad effect of shipping rings on British commerce, and the remedy. 2500 w. Engng—Nov. 11, 1898. No. 24067 A.

Syndicates.

The French Rubber Syndical Chamber. E. Chapel. An explanation of the "Syndicats Professionnels" which have become of considerable importance in France. 1300 w. Ind Rub Wld—Nov. 1, 1898. No. 23762 D.

Timber.

The Timber Wealth of Pacific North America.

Frank Haines Lamb. Describes varieties of timber, quality of woods, output of mills and capacity of forests, shipments from various points and the evolution of the immense timber industry of the Pacific Coast. 4000 w. Engineering Magazine—Dec., 1898. No. 24290 B.

U. S. Trade.

United States Trade with Latin America. The latest statement showing the exports and imports. 2700 w. Bul of Bureau of Am Reps—Oct., 1898. No. 23847 C.

Yokohama.

Trade of Yokohama in 1897. Editorial discussion of the general increase of British trade, based on figures compiled by the British Acting Consul General from revised customs returns. 2000 w. Engng—Nov. 18, 1898. No. 24275 A.

CURRENCY AND FINANCE.

Chile.

Financial Conditions in Chile. An interesting review of the history of the situation, showing the causes leading to the failure of the resumption act of 1895, and some of the immediate effects of the law of 1898. 5000 w. U. S. Cons Repts—Nov., 1898. No. 23809 D.

Financial Position of Chile. A letter from Señor Don Eliodoro Infante, dated Aug. 24, 1898, addressed to the Sec. of the Nat. Sound Money League at Chicago. States the conditions affecting the currency problem. 1500 w. Bul of Bureau of Am Reps—Nov., 1898. No. 24267 C.

Finance.

Industrial Finance. An English editorial discussing the risks and advantages of the systems for raising money for use in manufacturing and trading concerns. 2800 w. Engng—Oct. 21, 1898. No. 23731 A.

India.

The Indian Exchange Banks and the Currency Puzzle. An article on the finance of trade. 3500 w. Bankers' Mag, Lond—Nov., 1898. No. 23848 C.

GOVERNMENTAL CONTROL.

Public Works.

Municipal Control of Public Works. H. J. Malochee. A discussion of the various plans adopted and suggested, and of the reasons for and against municipal control. 4500 w. Jour Assn of Engng Soc's—Oct., 1898. No. 23981 C.

LABOR.

Compensation Act.

The Working of the Compensation Act at Yorkshire Collieries. James Lindsay. Read at meeting of the Yorkshire Branch of the National Assn. of Colliery Managers. Thinks that four months' experience shows that it affects employers most seriously and unjustly, and is not a blessing to the employed. Gives instances in the district named. 2300 w. Ir & Coal Trds Rev—Nov. 11, 1898. No. 24060 A.

Hours of Labor.

Eight Hours and the Constitution. On the need of establishing uniform hours of labor throughout the whole country. 3500 w. Gunton's Mag—Nov., 1898. No. 23808 C.

Management.

The Management of Men. Editorial on the address of Sir Benjamin C. Browne to the North-East Inst. of Engs. and Shipbuilders. 1800 w. Engng—Oct. 21, 1898. No. 23733 A.

Strikes.

Strikes and Lockouts in 1897. Statistics from the latest annual report of the British Board of Trade, with comments. 1600 w. Col Guard—Nov. 11, 1898. No. 24054 A.

Trade Disputes.

Conciliation and Arbitration in Trade Disputes. From an article by Sir Edward Fry in the Nov. issue of the *Law Magazine and Review*. Considers the Conciliation Act now in force in England. 1200 w. Col Guard--Nov. 4, 1898. No. 23941 A.

MISCELLANY.

Coal Industry.

The Coal Industry as an Index of National Progress. A method of testing the industrial life of the nation in comparison with other countries, based on the use of coal for power purposes. 2300 w. Col Guard--Oct. 28, 1898. Serial. 1st part. No. 23865 A.

Disarmament.

The Tsar's Eirenicon. E. J. Dillon. A discussion of the Tsar's proposal, the diplomatic action about to be taken, the difficulties, and various phases of the problem. 15,300 w. Contemporary Rev—Nov., 1898. No. 23955 D.

Far East.

The Far Eastern Crisis. Archibald R. Colquhoun. A discussion of this question, which has become of importance to all the world, and of the Burlingame policy which has been followed by Engand and the United States, showing its effect in relation to the present situation, 6000 w. N Am Rev—Nov., 1898. No. 23-775 D.

Fibre Industries.

The Possible Fibre Industries of the United States. Charles Richards Dodge. Shows the importance of these industries as new sources of national prosperity, outlining the difficulties of the problem and the points of vantage. Ill. 5500 w. Ap Pop Sci M—Nov., 1898. No. 23720 D.

Junior Republic.

A Novel Educational Experiment. Charles Burr Todd. An account of this interesting work among the poor children, and its latest developments. 4000 w. Gunton's Mag—Nov., 1898. No. 23807 C.

Rhea Fibre.

The Preparation of Rhea Fibre for Textile Purposes. Perry F. Nursey. Read before the Society of Engineers. The experiences of the writer with this product, supplemented by the work of others. 4500 w. Ind & Ir—Nov. 11, 1898. Serial. 1st part. No. 24052 A.

Sulphuric Acid.

Sulphuric Acid and the By-Products from Iron Pyrites. R. G. Ewer. Reviews the early history the various improvements, and present mode of manufacture. 4800 w. Jour Assn of Engng Soc's—Oct., 1898. No. 23982 C.

Tropical Development.

European Experience with Tropical Colonies. W. Alleyne Ireland. Reviews the experience of France, Holland and Great Britain, and gives the opinion that when the population is composed entirely of negroes, success requires a system of forced labor. 4600 w. Atlantic M—Dec., 1898. No. 24230 D.

Our Government of Newly Acquired Territory. Carl Evans Boyd. Reviews the extensions of the United States in the past and the territorial governments established, and discusses the differences which must influence governmental policy in dealing with recently acquired possessions. 4500 w. Atlantic M—Dec., 1898. No. 24231 D.

The United States and the Control of the Tropics. Benjamin Kidd. Discusses whether the United States can safely enter upon a policy of expansion. The article is called out by queries in a letter from the editor. 4300 w. Atlantic M—Dec., 1898. No. 24229 D.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Ancient Telegraphy.

Ancient Methods of Telegraphy. Lawrence Irwell. Describes the kinds of telegraphy used before the invention of the electrical apparatus. 2200 w. Elec Engng—Nov., 1898. No. 24033.

Electric Bells.

Electrical Alarums. J. Ebel. A general illustrated description of recent improvements. 1500 w. Elec Rev, Lond—Oct. 28, 1898. No. 23858 A.

Electrical Plant.

Electrical Plant, Indo-European Telegraphs, Karachi. Some particulars in regard to the electrical plant sent to light these offices, with the object of giving a cooler and better light to the signallers. 1300 w. Ind Engng—Oct. 8, 1898. No. 23899 D.

Exchange.

New Telephone Exchange at Newport, R. I. An illustrated description of the new building and its equipment. 700 w. Elec Eng, N. Y.—Nov. 10, 1898. No. 23824.

French Cable.

The New French Atlantic Cable. An account of the construction and laying of this cable which connects Brest with Cape Cod. It is the longest submarine cable in existence, and is remarkable in having a heavier core than any other section. 1000 w. Elec Eng, N. Y.—Nov. 10, 1898. No. 23823.

Grapnels.

Submarine Cable Grapnels. Charles Bright. A statement of the requirements, with illustrated description of grapnel apparatus. 2000 w. Engng—Nov. 4, 1898. Serial. 1st part. No. 23935 A.

Space Commuication.

Tesla's Latest Invention. Text of a recent patent describing an invention for controlling the operations of a mechanism without any tangible connection and from a great distance. Also editorial. 1000 w. Elec Rev, N. Y.—Nov. 9, and 16, 1898. Serial. 2 parts. No. 23875.

Transmission of Power Through the Air Without Wires. John Trowbridge. Reports some experiments of the writer, interesting in connection with Mr. Tesla's recent patent of a method of transmitting power through the air without wires. 800 w. Sci Am—Nov. 19, 1898. No. 23975.

Submarine Cables.

The Extension of Submarine Telegraphy in a Quarter Century. Charles Bright. A very interesting description of the extension of submarine cables since the early days. Illustrated with a large map of the world showing all cable routes. Historical notes of interest concerning numerous cable projects. The capital invested to-day in cables is larger than that in any other branch of electrical industry, amounting to £55,000,000 sterling. 4000 w. Engineering Magazine—Dec., 1898. No. 24288 B.

The Development and Present Status of Submarine Telegraphy and Cables. Herbert Laws Webb. Based upon "Submarine Telegraphs," by Charles Bright. A review of this book with favorable comment. 6500 w. Elec Eng, N. Y. —Nov. 10, 1898. No. 23822.

Switchboard.

Multiple Telephone Switchboard (Commutateur Multiple Téléphonique). Dubreuil. General illustrated description of the principle of the multiple exchange switchboard. 1200 w. L'Electricien—Nov. 7 and 12, 1898. No. 24166 each B.

The Novel Switchboard at the Harlem Exchange of the New York Telephone Company. Describes a new switchboard in which the miniature incandescent lamp signals so distinctly that the operators work is reduced to the simplest operations. 1000 w. Elec Eng, N. Y.—Nov. 24, 1898. No. 24081.

Telephone Signal.

Evolution of the Telephone Signal. H. P. Clausen. Gives the history of signalling apparatus as used in telephone work. Ill. 2500 w. W Elect'n—Nov. 19, 1898. No. 24074.

DISTRIBUTION.

Converters.

Rotary Converters. Silvanus P. Thompson. Read before the Inst. of Elec Engs., England. Describes a rotary converter and considers the machines devoted to the purpose of converting continuous currents into alternating currents of of one, two, or three phases, or *vice versa.* 3300 w. Elec Eng, Lond—Nov. 11, 1898. Serial. 1st part. No. 24050 A.

ELECTRO-CHEMISTRY.

Cadmium.

Some Notes on the Electro-Deposition of Cadmium and Its Alloys. Sherard Cowper-Coles. Explains why cadmium is used for the manufacture of fusible wires for electric cut-outs, and gives information concerning the deposition and the various alloys. 3500 w. Elec Rev, Lond—Oct. 21, 1898. No. 23719 A.

Copper Refining.

The Electro-Deposition of Copper. Reviews the history and progress of this electro-chemical industry, briefly describing the Elmore process and the Demoulin process. 1700 w. Engng—Oct. 21, 1898. No. 23734 A.

Metallurgy.

The Electrolytic Winning of Metals Direct from the Ore. (Ueber Elektrolytische Reingewinnung von Metallen Direkt aus Ihren Erzen.) Dr. C. Hoepfner. A description of the author's process of separating copper by the use of chloride of copper as a solvent for the ore, followed by electrolytic reduction. 3000 w. Elektrotech Zeitschr—Nov. 3, 1898. No. 24141 B.

ELECTRO-PHYSICS.

Alternate Currents.

Notes on Alternate Current Calculations. The first of a series of articles on the arithmetic of alternate current distribution, including arithmetical examples relating to polyphase currents. 900 w. Elec, Lond—Oct. 28, 1898. Serial. 1st part. No. 23857 A.

Magnetism.

Magnetic Researches. (Magnetische Untersuchungen) Dr. Erich Schmidt. A general review of the fundamental notions of magnetism and magnetic phenomena, with explanations and definitions especially intended to inform the general engineer. Serial, Part 1. 4000 w. Zeitschr f Elektrochemie—Nov. 3, 1898. No. 24142 G.

Sheet Iron.

Investigations of Sheet Iron. (Untersuchungen von Eisenblechen.) W. Röhr. A detailed account of experimental tests of the magnetic properties of sheet-iron plates, with tables of data and results. The experiments were made both with direct and alternating currents. 3000 w. Electrotech Zeitschr—Oct. 27, 1898. No. 24138 B.

Radiography.

The Progress of the Technique of Röntgen Rays. (Die Fortschritte der Roentgentechnik). A general review of the advance which has been made in the technique of radiography since the original discovery of Prof Röntgen. 3000 w. Schweizerische Bauzeitung—Nov. 5, 1898. No. 24130 B.

X-Rays in the Army. H. Lyman Sayen. The arrangements for x-ray work at Fort McPherson, Ga., and the success in diagnostic work. 1700 w. Elec Wld—Nov. 5, 1898. No. 23804.

GENERATING STATIONS.

Alternator.

Compounding Alternators for Constant Voltage. (Sur le Compoundage des Alternateurs à Voltage Constant). Maurice Leblanc. Illustrated description of an ingenious auxiliary exciting method which is applicable to alternators having high armature reactance, permitting them to be paralleled, etc. 1200 w. Comptes Rendus—Nov. 7, 1898. No. 24187 D.

Belfast, Ireland.

The Belfast Electricity Works. History of the undertaking with illustrated description of these new works 4000 w. Elec Eng, Lond—Oct. 21, 1898. No. 23711 A.

Boston, Mass.

Ths Boston Electric Light Company's New Station. Illustrated description of a 9000 kilowatt plant generating three-phase current for public and private lighting service. The building measures 244x174 ft. and contains unusual structural and mechanical features. 2600 w. Eng Rec—Nov. 19, 1898. No 24023.

The New Generating Station of the Boston Electric Light Company. Illustrates and describes a system in course of construction with the view of bringing an old installation up to date. 3000 w. Elec Wld—Nov. 19, 1898. No. 23969.

The New Station of the Boston Electric Light Company. Illustrates and describes the new plant, located in South Boston, from which current is distributed by the three phase system. 2500 w. Elec Eng, N. Y.—Nov. 24, 1898. No. 24079.

Commutators.

Notes on Commutator Design. F. J. A. Matthews. Considers faults in construction, bad connections, and the using too small a commutator. 2300 w. Elec Rev, Lond—Oct. 21, 1898. No. 23718 A.

Dynamo Calculations.

Short Cuts in Dynamo Calculations. Cecil P. Poole. Gives analysis of method, the object of which was economy in time, now modified so as to make it applicable to standard practice in designing. 1500 w. Elc Wld—Nov. 26, 1898. No. 24093.

Dynamo Test.

Test of a Multi-Circuit Direct-Current Dynamo. Edward J. Murphy, Jr., and P. Edwin Van Saun. Describes a test of the Rushmore dynamo. Ill. 2200 w. Am Elect'n—Nov., 1898. No. 23740.

Florence.

The Central Station of the Società Toscana in Florence. (La Stazione Centrale della Società Toscana in Firenze.) Alberto Picchi. Short description of an important new Italian railway, lighting and power distribution station. Accumulators and a 3-wire 300 volt system are used. 1100 w. Rivista Gen delle Ferrovie—Nov. 6, 1898. No. 24194 B.

Folkestone.

The Folkestone Electricity Supply Works. Illustrated detailed description of electric-lighting plant. 2400 w. Elect'n, Lond—Nov. 11, 1898. No. 24039 A.

Hull, England.

Hull New Central Station. Brief history of the work at this place since 1889, with an illustrated description of the new works. 1400 w. Elec Eng, Lond—Oct. 28, 1898. No. 23855 A.

Isolated Plant.

Lighting Plant of the Empire Building, New York City. Illustrated description of a 350 k. w. plant in a 21-story building. 1400 w. Eng Rec—Nov. 26, 1898. No. 24226.

Llandudno, Wales.

Llandudno Municipal Electric Supply Works. Illustrates and describes a system of electrical supply for a North Wales watering place. 2200 w. Elect'n, Lond—Oct. 28, 1898. No. 23-856 A.

Nuremberg.

The Electric Plant of the City of Nuremberg. (Das Städtische Elektricitätswerk Nürnberg.) Philipp Scholtes. A very complete and fully illustrated account of this important station, in which current is generated and distributed for lighting and power. Valuable data as to costs are given. Two articles. 12000 w. Electrotech Zeitschr—Nov. 3, 10, 1898. No. 24139 each B.

Polyphase Practice.

Polyphase Practice in Small Stations at the Plant of the Hackensack Gas and Electric Company. A description, with illustrations, of the equipment and service of the plant of the Hackensack Gas and Electric Co. 2200 w. Am Elect'n—Nov., 1898. No. 23738.

Power Plant.

Power Plant of the Washington Mills Company, Lawrence, Mass., U. S. A. Explains the need of increasing the power, and gives illustrated description of the specially designed boilers, and report of the engine trials. 3500 w. Engng—Oct. 21, 1898. No. 23737 A.

Power Station.

The Mammoth Central Power Station of the Metropolitan Street Railway Company, New York. Brief illustrated description of a power house of a 70,000 h. p. capacity, designed to supply power to all the electric lines of this company. 1500 w. Sci Am—Nov. 12, 1898. No. 23890.

Sarajevo, Bosnia.

The Electric Station at Sarajevo. (Das Elektricitätswerk in Sarajevo.) Ludwig Spängler. An illustrated account of this important hydraulic power electric station, and description of the applications of current for lighting and tramways. 7500 w. 2 plates. Zeitschr d' Oesterr Ing u Arch Ver—Oct. 21, 1898. No. 24114 B.

Small Plants.

Economies in Small Electric Light Plants. E. P. Roberts. Read before the Ohio Elec. Assn. Discusses how to operate a small plant economically. 5000 w. W Elect'n—Nov. 19, 1898. No. 24073.

Washington, D. C.

The United States Electric Lighting Company of Washington, D. C., and Its New Electrical Equipment. Nevil Monroe Hopkins. Gives briefly the history of the company, with illustrated description of its fine new central station and its equipment. 4500 w. Elec Eng, N. Y. Nov. 3, 1898. No. 23766.

HEATING AND WELDING.

Warming.

Electric Heating. (Elektrische Heizung.) An address by Dr. Voit before the German Society of Heating and Ventilating Engineers, giving data and methods for the proportioning and application of electric apparatus for warming; with discussion showing the cost of the method. 3000 w. Gesundheits Ingenieur—Oct. 15, 1898. No. 24126 B.

LIGHTING.

Arc Lamps.

Improvements in the Arc Lamp. Robert A. Ross. Reviews the history of the arc lamp from its commercial beginning in 1879, the various types of lamps, and the present practice. 2600 w. Can Elec News—Nov., 1898. No. 23932.

The Illumination of Manufacturing and Business Establishments by the Arc Light. (Fabrik und Bureaubeleuchtung durch Bogenlicht.) A discussion as to the best method of suspending, distributing and reinforcing arc lamps in the illumination of workshops, &c. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 5, 1898. No. 24112 D.

Decorative Effects.

Electricity in the Schilling Gardens. R. W. Lohmann. Illustrates and describes the private grounds of A. Schilling, in Oakland, Cal., with special reference to the electrical features. 2800 w. Jour of Elec—Oct., 1898. No. 23962.

Electric Lighting as Applied to Architecture. Thomas Ekin. Read at meeting of the Archt. Assn. Discusses the use of the incandescent electric lamp and urges the consideration of each room separately with a view to the purpose for which it is to be used, general surroundings, &c. Also considers the wiring. 2200 w. Elec, Lond—Nov. 16, 1898. No. 23968.

MEASUREMENT.

Phasemeter.

Dobrowolski's Phasemeter. (Phasemètre de von Dolivo Dobrowolski). M. Aliamet and E. J. Brunswick. Illustrated description of a simple and ingenious instrument which gives direct readings of phase displacement. 800 w. L'Electricien—Oct. 29, 1898. No. 24165 B.

Wright Meter.

The Wright Discount Meter and Its Use in Central Station Management. Illustrated detailed description of what is claimed to be a very useful instrument. 2000 w. Elec Eng. N. Y. —Nov. 24, 1898. No. 24080.

POWER APPLICATION.

Diagrams.

A Practical Method of Determining the Diagrams of Polyphase Motors. (Praktische Vorausbestimmung der Drehstrommotoren.) A. Rothert. A geometric method of calculating the complete diagram in advance of the construction of the motor. 2000 w. Elektrotech Zeitschr—Nov. 3, 1898. No 24140 B.

Drill.

A German Electric Drill. W. Meissner. Illustrates and describes features of a machine which is soon to be put in operation in Colorado. 1500 w. Mod Mach—Nov., 1898. No. 23831.

Electric Locomotive.

See Street and Electric Tramways.

Electrical Machinery.

Some French Electrical Machinery. Illustrates and describes products manufactured by Fabius Henrion, Nancy, France, showing how they differ from American designs. 3000 w. Elec Wld—Nov. 19, 1898. No. 23970.

Electric Printing.

The Electrical Equipment of a Model Printing Establishment. George A. Damon. Slightly abstracted reprint of a paper read before the Chicago Elec. Assn., describing and illustrating the model printing establishment of the W. B. Conkey Co., at Hammond, Ind. 4800 w. Elec Wld—Nov. 12, 1898. No. 23898.

Electric Pumps.

The Application of Electric Power to Pumping Machinery. S. H. Bunnell. A fully illustrated description of all the modern forms of electrically operated pumps, for mining and other purposes. Shows the opportunity for further development of electric pumps. 3000 w. Engineering Magazine—Dec., 1898. No. 24289 B.

Elevators.

The Electric Elevator Equipment for the Central London Underground Ry. An illustrated description of an interesting electric elevator equipment being installed by the Sprague Electric Co., of New York city. 6000 w. Eng News—Nov. 3, 1898. No. 23770.

TRANSMISSION.

High Voltage.

High-Voltage Power Transmission. Charles F. Scott. Describes important work in this field, giving the methods by which measurements have been made and the results which have been reached, and a number of points of interest regarding long distance transmission plants. 12-500 w. Trans Am Inst of Elec Engs—Oct., 1898. No. 24078 D.

Insulation.

Apparatus for Direct Indication of Loss of Current. (Isolationskontrollsystem zur Direkten Anzeige Stromentweichungen.) Dr. M. Kallman. A description of a special form of ampere meter by means of which imperfections in the insulation of a distributing system may be detected. Two articles. 7000 w. Elektrotech Zeitschr—Oct. 13, 20, 1898. No. 24136 each B.

Lightning Arresters.

Types of American Lightning Arresters. Henry E. Raymond. Illustrates and describes many types, showing the great dissimilarity in the application of similar principles. 2200 w. Am Elect'n—Nov., 1898. No. 23741.

Mine Transmission.

Electrical Transmission of Power in Mining. W. B. Esson. Abstract of paper read at meeting of Inst. of Civ. Engs. (England). Describes the plant erected at the Sheba Gold Mining Company's Mine. 1100 w. Col Guard—Nov. 18, 1898. No. 24279 A.

Switzerland.

The Transmission Plant Les Clees Yverdon. J. Laffargue, in *L'Industrie Electrique*. Translated description with comments from an American point of view. Ill. 1500 w. Elec Wld—Nov. 26, 1898. No. 24092.

MISCELLANY.

Address.

Applications of Electricity. W. H. Preece. Abridged from an inaugural address delivered at the Inst. of Civ. Engs. (England). Shows the enormous strides made in the use of electricity, touching on special applications in various fields. 3800 w. Nature—Nov. 3, 1898. No. 23-959 A.

Electro-Therapeutics.

High Frequency Oscillators for Electro-Therapeutic and other purposes. Nikola Tesla. Read at meeting of American Electro-Therapeutic Assn., at Buffalo, N. Y. An account of the writer's experiments in this field, describing apparatus used. Ill. 7000 w. Elec Eng, N. Y.—Nov. 17, 1898. No. 23967.

Nomenclature.

A Nomenclature for the Characteristic Magnitudes for Alternating Currents. (Zur Benennung der Charakteristischen Grössen des Wechselstromkreises.) C. P. Feldmann. An attempt to derive a distinctly Teutonic nomenclature, to replace the terms derived from classical roots and used by all other scientific nations. 4000 w. Elektrotech Zeitschr—Oct. 20, 1898. No. 24137 B.

MARINE ENGINEERING.

Battleships.

See Military Engineering.

Bulkheads.

Test of the Bulkhead Separating the Engine Rooms of the Battleship "Illinois." J. J. Woodward. Abstract of a paper read at meeting of the Soc. of Naval Archts. and Marine Engs Describes the three tests made, giving results Ill. 3300 w. Eng News—Nov. 17, 1898. No 24002.

Test of the Strength of a Longitudinal Bulkhead Separating two Engine Rooms. J. J. Woodward. With description of the bulkhead construction on the U. S. S. Kearsarge, Kentucky, and Illinois, and an account of the tests. 4500 w. 4 plates. Trans Soc N A & M E—1898. No. 24257 F.

Cruiser.

See Military Engineering.

Derrick.

An Electrically Operated 150-Ton Revolving Derrick. Walter A. Post. A general description of the derrick at the yards of the Newport News Shipbuilding and Dry Dock Co., with numerous detail drawings. 4000 w. 10 plates. Trans Soc N A & M E—1898. No. 24258 F.

Feed Pump.

See Mechanical Engineering, Steam.

Gunboats.

See Military Engineering.

Launching.

Launching Mishaps. Gives a brief enumeration of representative examples, with remarks. 1700 w. Engr, Lond—Oct. 21, 1898. No. 23722 A.

Meteorology.

The Origin of Storms. (Sopra le Origini delle Tempeste.) G. Tolomei. A general dissertation on the various theories of the nature and origin of storms, illustrated with diagrams. 8000 w. Rivista Marittima—Aug.-Sept., 1898. No. 24191 H.

Mishaps.

Mishaps at Sea. An account of the loss of the Atlantic Transport Line steamship Mohegan, off the Lizard, England, and other vessels. Ill. 1000 w. Marine Engng—Nov., 1898. No. 23836 C.

Navigation.

Abacus for Calculating Latitudes from Meridian Altitudes. (Abbaco per il Calcolo della Latitudine Medianti un'Altezza Circummeridiana.) G. Pesci. Illustrated description of a simple and rapid method of finding latitudes at sea. 3500 w. Rivista Marittima—Oct., 1898. No. 24193 H.

Paddle-Wheels.

Paddle Wheels. A. E. Mills. Paper read before the Inst. of Marine Engs. Traces the development from the earliest form used, and analyzes their working. Ill. 2000 w. Mech Wld—Oct. 28, 1898. No. 23820 A.

Shipbuilding.

Methods of Securing Watertight Work. H. G. Smith. A discussion of the best methods of construction for bulkheads, double-bottoms, &c., in order that watertight work may be assured, with especial reference to the vessels of the U. S. Navy. 7500 w. 9 plates. Trans Soc N A & M E—1898. No. 24256 F.

The Steel Foundation of the Shipbuilding Industry. James Riley. A history of the use of steel in shipbuilding. The article describes fully the troubles encountered by the British Admiralty in the earlier attempts to build steel ships, the growth of the steel-making industry and the improvement and standardizing of the product. The machinery of the steel mill and its evolution are described. The recognition of the possibilities of steel by the marine engineer led to the greatest triumphs of his profession. 4500 w. Engineering Magazine—Dec., 1898. No. 24285 B.

Stability.

Bilge Keels and Rolling Experiments. Lawrence Spear. A description of the manner in which bilge keels were added to the U. S. S. Oregon, together with an account of the experimental demonstration of the effect in increasing stability. 4000 w. 4 plates. Trans Soc N A & M E—1898. No. 24251 F.

Stability of a Battle-ship Under Damaged Conditions. C. H. Peabody. A study of stability based upon experiments upon a model, with numerous diagrams. 2000 w. 3 plates. Trans Soc N A & M E—1898. No. 24259 F.

Steamship.

Steamship Kaiser Wilhelm der Grosse. (Le Paqueboat Kaiser Wilhelm der Grosse.) M. Hachebet. Illustrated description of the boilers and engines, refrigerating and electric lighting plants, with plate giving two plans and longitudinal section. 6000 w. Le Génie Civil —Oct. 15, 1898. No. 24150 D.

S. S. Winifred, the Pioneer American Steel Cargo Ocean Steamship. William A. Fairburn. Illustrated detailed description with dimensions and report of trials. 1700 w. Marine Engng—Nov., 1898. No. 23833 C.

Wave Propulsion.

A Wave-Propelled Boat. Illustrates and describes a device attached to boats for producing motion, invented by H. F. L. Linden. 1100 w. Sci Am—Nov. 12, 1898. No. 23894.

Yachts.

See Military Engineering.

MECHANICAL ENGINEERING.

AUTOMOBILISM.

Battery Handling.

The Electric Vehicle Company's Battery Handling Machinery. Hugh Dolnar. Describes and illustrates devices invented by G. Herbert Condit, for handling and charging storage batteries on a large scale. 3000 w. Am Mach—Nov. 10, 1898. No. 23901.

Design.

A Design for an Electric Automobile Vehicle. Charles T. Child. Working drawings and description of a type of motor vehicle that can be constructed by an amateur of ordinary mechanical skill, and at comparatively small cost. 5000 w. Sci Am Sup—Nov. 26, 1898. No. 24085.

Heavy Weights.

Electric Automobiles at the Paris Concourse. Compiled and translated from the French technical journals. The first of a series of articles describing the vehicles and their performance. Ill. 6000 w. Elec Wld—Nov. 5, 1898. Serial. 1st part. No. 23805.

Heavy Motor-Car Trials in France. An account of the trials with illustrations of the vehicles. 3200 w. Engr, Lond—Oct. 28, 1898. No. 23872 A.

Second Concourse of Heavy Weights. (Deuxième Concours des Poids Lourds.) Ch. Talausier. Short description of the concourse with table of data of competing vehicles. 2400 w. Le Génie Civil—Oct. 15, 1898. No. 24152 D.

The Heavy Motor Car Trials in France. Discusses the recent trials and what they have proved. 2000 w. Engr, Lond—Nov. 4, 1898. No. 23945 A.

Law.

The French Law Relating to Automobilism. A free translation of the new law lately passed by the States Council. 2200 w. Automotor Jour—Oct. 15, 1898. No. 23717 A.

Motor Vehicles.

Some Sanitary and Allied Advantages Attending the Introduction and Use of Moto-Vehicles. E. Schrapnell Smith. Excerpt from a paper read before the Sanitary Inst. of Birmingham, Eng. The advantages claimed are considered under the divisions of improvement in sanitary conditions, and reduction in public expenditure. 2700 w. Automotor Jour—Oct. 15, 1898. No. 23716 A.

Trials.

The Royal Agricultural Society's Trials of Moto Vehicles. The judge's report, description of vehicles, summary of times and speeds, consumption of fuel and cost of running, with conclusions. 5000 w. Automotor Jour—Oct. 15, 1898. No. 23715 A.

HYDRAULIC ENGINEERING.

Hydraulics.

The New Hydraulics: An Essay for Advanced Students in the Art, and for Those who Look Beneath the Surface Clemens Herschel. Reviews important experiments, and urges the collection of new coefficients derived from experiment. 1300 w. Eng News—Nov. 10, 1898. No. 23883.

Flow.

Formulæ for the Flow of Water in Open Channels. (Formeln zur Berechung des Wasserabflusses in Offenen Gerinnen.) R. Siedek. A comparison of the measurements made on the Danube at Vienna with the computed flow by the formulas of Bazin and of Kutter. 1200 w. Oesterr Monatschr f d Oeffent Baudienst—Nov., 1898. No. 24124 D.

MACHINE WORKS AND FOUNDRIES.

Boring Machine.

Horizontal Boring and Milling Machine. (Horizontal- Bohr- und Fräsmaschine.) Brief illustrated description of a powerful machine-tool, with plate giving working elevation drawing. 1000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Oct. 22, 1898. No. 24103 D.

Casting.

Casting a Corliss Cylinder. R. H. Palmer. Illustrates and describes the manner of casting as approved by William H. Harris, builder of the Harris-Corliss engine. He considers this type of cylinder is more satisfactory cast horizontally and with the valve seats vertical. 2000 w. Am Mach—Nov. 24, 1898. No. 24096.

Casting a Locomotive Cylinder. W. T. Mohan. A description of present practice. 1200 w. Sib Jour of Engng—Nov., 1898. No. 23989 C.

Cast Iron.

Cast Iron. Dr. Richard Moldenke. Read before the Engs. Soc. of W. Penna, at Pittsburg. Considers the materials, processes of melting, constitution, micro-structure, segregation and shrinkage, tests, &c. 4000 w. Ir Trd Rev—Nov. 17, 1898. No. 23990.

Cost-Keeping.

A Simple and Effective System of Shop Cost-Keeping. H. M. Norris. Describes fully a simple and effective system of gauging the cost of work in process of manufacture, with many blank forms found useful in experience. A practical and valuable article. 4500 w. Engineering Magazine—Dec., 1898. No. 24286 B.

Drill.

A Large Radial Drill. (Grosse Radialbohrmaschine.) Description, with photograph, and working plan and elevation of a large radial drill press adapted either for belt or electric driving. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 5, 1898. No. 24111 D.

See also Electrical Engineering, Power Application.

Engine Works.

Lincoln Engine Works, Chesterfield. Illustrates and describes a well thought out plan of engineering works, giving details of construction of the building and the general design. 2800 w. Engng—Nov. 11, 1898. Serial. 1st part. No. 24066 A.

Floors.

Best Floors for Shops and Round Houses. Extracted from a committee report presented at the convention of Assn. of Ry. Supts. of Bridges and Buildings. Ill. 2300 w. Ry & Engng Rev —Oct. 22, 1898. No. 23800.

Fly-Wheels.

The Bursting of Small Cast-Iron Fly-Wheels. Charles H. Benjamin. Describes a series of experiments on small cast-iron wheels, at the Case School of Applied Science, for the purpose of investigating the causes of failure. Ill. 2800 w. Trans of Am Soc of Mech Engs, No. 795 —Nov., 1898. No. 24237 D.

Lathes.

A Special Lathe for Threading Taps. Illustrates and describes a special tool made for a tap and die factory, to cut threads upon the taps. 800 w. Am Mach—Nov. 17, 1898. No. 23971.

Lathe Attachment for Turning Cast Wrist Pins. C. P. Benns. Illustrates and describes the arrangement and its operation. 1500 w. Am Mach—Nov. 3, 1898. No. 23791.

Locomotive Boiler.

How to Lay Out a Locomotive Boiler. Henry J. Raps. Method of laying out a taper course or the frustum of a right cone and its application to the laying out of an elbow. 1200 w. Loc Engng—Nov., 1898. No. 23778 C.

Machine.

What is a Machine? (Was ist eine Maschine.) P. K. V. Englemeyer. A discussion of the meaning and scope of the word "machine" from the kinematic standpoint, giving the critical definitions of various authorities, 2500 w. Zeitschr d Ver Deutscher Ing—Oct. 22, 1898. No. 24106 D.

Molding.

Ethics of Bench Molding. Henry Hansen. Some remarks on small castings, the causes of their not being true to pattern, &c. 2500 w. Am Mach—Nov. 17, 1898. No. 23972.

Riveting.

Portable Pneumatic Riveters. Describes results obtained in a large shipyard. 800 w. Eng Rec—Nov. 19, 1898. No 24020.

Portable Pneumatic Riveters in Shipbuilding. W. I. Babcock. A discussion of the advantages of power riveting in general, and of the especial applicability of pneumatic riveting to shipbuilding. 3000 w. 12 plates. Trans Soc N A & M E—1898. No. 24253 F.

Screw-Threads.

The Present Status of a Standard Metric Screw Thread System. (Referat über den Gegenwärtigen Stand der Frage Betreffend die Einführung eines Metrischen Gewindesystems.) A discussion, by the German Railway Society, of the metric screw-thread system proposed by the international commission at Berne. 3500 w. Glaser's Annalen—Nov. 1, 1898. No. 24121 D.

Zurich International Congress for Standardizing Threads. (Congrès International pour l'Unification des Filetages à Zurich.) Ed. Sauvage. Short account of the more important conclusions reached by the congress. The system is practically that of the French Société d'Encouragement. 900 w. Bulletin de la Société d'Encour—Oct., 1898. No. 24173 G.

Seamless Tubing.

The McCool Seamless Tubing. An illustrated account of the manufacture of seamless steel tubing by a new process of rolling. 1200 w. Am Mfr & Ir Wld—Nov. 11, 1898. No. 23933.

Springs.

The Computation of Springs for Valves of Engines and Compressors. (Berechnung der Federn für die Ventile von Dampfmaschinen und Kompressoren.) W. Trinks. A very thorough discussion of the proportioning of springs for the correct closing of valves, with numerous practical examples. 4500 w. Zeitschr d Ver Deutscher Ing—Oct. 15, 1898. No. 24102 D.

Tool Shop.

A Notable German Tool Shop. F. J. M. Illustrated description of the shops of J. E. Reinecker, Chemnitz, Germany, and the methods employed there. 2500 w. Am Mach—Nov. 3, 1898. No. 23790.

Tools.

Steam Engine Tools and Gages used by Struthers & Wells Iron Works. John Randol. Illustrates and describes the tools and fixtures used. 2000 w. Am Mach—Nov. 24, 1898. No. 24094.

Wheel Rims.

Note on Strength of Wheel Rims Albert K. Mansfield. Calling attention to the fact that under some conditions ribbing does not have a strengthening effect. Ill. 700 w. Trans of Am Soc of Mech Engs, No. 794—Nov., 1898. No. 24236 D.

Worm Wheels.

Experiments with Wormwheel Driving. (Versuche mit Schneckenradgetrieben.) R. Stribeck. A record of quantitative tests of efficiencies of worm gear driving at various pressures and speeds; being a continuation of experiments published last year. A valuable paper. 3500 w. Zeitschr d Ver Deutscher Ing—Oct. 15, 1898. No. 24101 D.

MATERIALS OF CONSTRUCTION.

Ceramics.

Observations upon the Research upon Expansion of Pastes by M. Coupeau. (Observations Déduites de l'Etude sur les Dilatations Céramiques de M. Coupeau.) Georges Vogt. An addendum to Coupeau's paper containing further data 2800 w. Bulletin de la Société d'Encouragement—Oct., 1898. No. 24175 G.

Research upon the Expansion of Ceramic Pastes. (Etude sur la Dilatation des Pates Céramiques.) M. Coupeau. A very elaborate illustrated paper containing a large number of tables of data, and giving the results of a very great amount of experimental work. A valuable and important paper. 14,000 w. Bulletin de la Société d'Encouragement—Oct., 1898. No. 24174 G.

Some Physical Properties of Ceramic Pastes. (Sur Quelques Propriétés Physiques des Pates Céramiques.) M. Le Chatelier. Some valuable data, supplementing M. Coupeau's researches, giving measurements of the shrinkage, porosity, coefficients of elasticity, and tenacity of numerous pastes and glazes. 1800 w. Bulletin de la Société l'Encouragement—Oct., 1898. No. 24176 G.

Copper.

The Chemistry of Materials of Engineering—Copper. A. H. Sexton. Discusses the physical and chemical properties of the metal, the sources, metallurgy, &c. 2400 w. Prac Engr—Oct. 21, 1898. No. 23713 A.

Metalloids.

Metalloids in Castings. Malcolm McDowell. Read before the Western Foundrymen's Assn., at Chicago. Discusses the things that give value to pig iron, grading of foundry iron, &c., with discussion. 4000 w. Ir Trd Rev—Nov. 24, 1898. No. 24089.

Steel vs. Iron.

Steel for Axles, Crank Pins and Piston Rods. Editorial discussing the increasing use of steel, the care needed in the preparation of specifications, the treatment of steel in the drop, &c. 800 w. Am Eng & R R Jour—Nov., 1898. No. 23752 C.

Test Bars.

Method of Casting Test Bars for the A. F. A. Testing Committee. Thomas D. West. Read before the Pittsburg Foundrymen's Assn. An illustrated description of the writer's method which has proved most successful. 3500 w. Ir Trd Rev—Nov. 24, 1898. No. 24088.

Testing.

Mechanical Testing of Materials. W. Gadsby Peet. From a paper read before the Inst of Mech. Engs. (Eng.) at the Oct. meeting. Describes the system adopted by the Midland Railway at Derby. Ill. 2000 w. Col Guard—Nov. 4, 1898. No. 23940 A.

POWER AND TRANSMISSION.

Belting.

Notes on Belting. G. R. MacLeod. Describes various kinds of belting in use and gives tests of leather, rubber, cotton and other belts. 3500 w. Can Elec News—Nov., 1898. No. 23931.

The Variation of Belt Tensions with Power Transmitted. William S. Aldrich. The purpose of the paper is to open a discussion on questions relating to belt tensions. Gives the writer's conclusions drawn from experiments. 2000 w. Trans of Am Soc of Mech Engs, No. 802—Nov., 1898. No. 24245 D.

Commercial Buildings.

The Mechanical Plant of a Modern Commercial Building. William H. Bryan. A discussion of the mechanical, steam, and electrical plants of such buildings. Ill. 15,800 w. Trans of Am Soc of Mech Engs, No. 801—Nov., 1898. No. 24242 D.

Compressed Air.

Economics in the Use of Compressed Air. R. P. Whitelaw. Read before the Mech. Engs'. Assn. of S. Africa. Presents the advantages of compressed air over other sources of power in deep mining, with suggestions for use. 3800 w. Mod Mach—Nov., 1898. No. 23832.

Compressors.

A Compound Duplex Automatic Air Compressor and the Largest Impulse Water Wheel in the World. E. A. Rix. Discusses the difficulties and usual methods of overcoming them, describes the ideal compressor, and the writer's method of constructing and operating compressed air engines. Ill. 3200 w. Am Mach—Nov. 10, 1898. No. 23900.

Power Cost.

The Cost of the Long Distance Electric Transmission of Large Powers. (Die Kosten der Elektrischen Uebertragung Grosser Kräfte auf Weite Entfernungen.) A discussion based on the data obtained from the power plant at Rheinfelden and applied to the proposed plant at Heimbach. 2500 w. Zeitschr d Ver Deutscher Ing—Oct. 29, 1898. No. 24110 D.

SPECIAL MOTORS.

Diesel Engine.

Progress of the Diesel Oil Engine. An account of the progress made by this interesting engine and the results achieved. 2000 w. Engr, Lond—Nov. 4, 1898. No. 23942 A.

Gas Engines.

Cheap Fuel Gas in Boston and the Future of the Gas Engine. An editorial review of the industrial changes caused by the distribution of cheap fuel gas. 900 w. Eng Rec—Nov. 12, 1898. No. 23919.

STEAM ENGINEERING.

Blowing Cylinders.

Smeaton and the First Use of Cast Iron Blowing Cylinders. Frank Firmstone. A review of the records and their probable correctness, concluding on the probable use between 1765 and 1768. 1400 w. Eng & Min Jour—Nov. 19, 1898. No. 24029.

Blowing Engine.

Compound Blowing Engine. (Verbund-Gebläsemaschine.) A. v. Jhering. Illustrated description of powerful horizontal compound blowing engine for the Hernadthal iron works at Krompach, Hungary. Corliss valve gear is used on both steam and air cylinders. 2000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Oct. 15, 1898. No. 24100 D.

Compound Blowing Engine Built for the Hernadthaler iron works, Krompach, Hungary. Translated from the *Zeitschrift des Vereines Deutscher Ingenieure.* Illustrates and describes an interesting horizontal blast-furnace blowing engine built in Bohemia. 800 w. Eng News—Nov. 10, 1898 No. 23889.

Boiler Explosion.

A Dynamite Boiler Explosion. An account of an explosion where the results seem to indicate the use of dynamite or its equivalent. An illustrated description. 1200 w. Locomotive—Oct., 1898. No. 23765.

The Birmingham Boiler Explosion. An illustrated description of the explosion on the premises of the Birmingham, Ala., Ice Factory Co., with discussion of the possible causes. 1400 w. Ice & Refrig—Nov., 1898. No. 23777 C.

The Sharlston Colliery Boiler Explosion. Illustrations and particulars of the explosion that took place at this colliery last July. 800 w. Ir & Coal Trds Rev—Nov. 4, 1898. No. 23952 A.

Boilers.

Improvements in Steam-Boilers, and the Brick Settings of Same. William Barnet Le Van. Illustrated detailed description of an improved boiler of the horizontal-flue class, and the requisites of a proper boiler setting. Considers the production of smoke to be due often to improper setting. 6000 w. Trans of Am Soc of Mech Engs, No 792—Nov., 1898. No. 24234 D.

Influence of Presence of Air upon the Efficiency of Boilers. (Influence des Rentrées d'air sur le rendement des Chaudières.) Abstract of a paper by M. Compère at the Congrès des Ingénieurs en chef, with discussion. 1000 w. Le Génie Civil—Oct. 15, 1898. No. 24154 D.

Boiler Trials.

Report of the Committee on the Revision of the Society Code of 1885, Relative to a Standard Method of Conducting Steam-Boiler Trials. Submits a revised code. The changes are mainly in the line of amendments shown by experience to be desirable. 15,000 w. Trans of Am Soc of Mech Engs, No. 805—Nov., 1898. No. 24245 D.

Combustion.

A New Process of Combustion. Paul J. Schlicht. An explanation of the writer's process with illustrated description of the invention. 3300 w. Jour Fr Inst—Nov., 1898. No. 23827 D.

Condensing Plant.

Cooling Tower and Condenser Installation. J. H. Vail. States the existing conditions previous to the installation, describes the plant in detail, and reports the advantage derived. 2000 w. Trans of Am Soc of Mech Engs., No. 804—Nov., 1898. No. 24244 D.

Cylinder Compression.

Experiments upon the Economy of Cylinder Compression in Condensing and Non-Condensing Engines. (Expériences faites, Sans et Avec Condensation, sur l'Economie de la Compression dans l'Espace Mort.) V. Dwelshauvers-Dery. A long illustrated article with many tables of test data. The conclusion drawn is that, for either form of engine, each point of cut-off has a corresponding best degree of compression. 12,000 w. Rev Universelle de Mines—Oct., 1898. No. 24184 G.

Cylinders.

Lagging Small Engine Cylinders. F. H. Illustrates and describes the work. 2500 w. Mech Wld—Nov. 11, 1898. No. 24037 A.

Dow Engine.

The Dow Engine. (Corliss Foundation.) Josiah Dow. An illustrated description of the writer's engine, an outgrowth of the Corliss, with a statement of the advantages secured. 6800 w. Pro of Engs Club of Phila, No. 67—Nov., 1898. No. 23984 C.

Draft.

Draft-Appliances—Ash Pans. F. P. Roesch. Deductions based on a series of experiements extending over a period of ten years, with different engines and coals. 800 w. Loc Engng—Nov., 1898. Serial. 1st part. No. 23779 C.

Engine Design.

American Engine Design from an English Standpoint. Charles Day. A letter calling attention to one or two points where the writer thinks American engine-builders might take a hint from English practice. Ill. 900 w. St Ry Jour—Nov., 1898. No. 23757 D.

Proper Proportional Parts of Engines. A topical discussion by Messrs. Vail, Schumann, Dow, Christie, and Schermerhorn. 4200. Pro of Engs Club of Phila, No. 67—Nov., 1898. No. 23983 C.

Expansion Governor.

Combined Engine and Dynamo. An illustrated description of an engine recently erected at the headquarters of the Metropolitan Fire Brigade (London) and forming a part of the electric light plant, especially describing a new form of governor. 1100 w. Engr, Lond—Nov. 4, 1898. No. 23948 A.

Feed Pump.

Economy Test of a Unique Form of Feed Pump. F. Meriam Wheeler. Data and results of test of vertical compound feed pump intended for use as a marine auxiliary of a less wasteful type than now generally in use. 2500 w. 2 plates. Trans Soc N A & M E.—1898. No. 24252 F.

Governor.

The Dow Chronometric Governor. Josiah Dow. Describes and illustrates the invention, explaining its action. 3500 w. Pro of Engs Club of Phila, No. 67—Nov., 1898. No. 23985 C.

Indicators.

Methods of Testing Indicators. D. S. Jacobus. Describes in detail the methods used at Stevens Institute of Technology, for the purpose of soliciting a discussion. Ill. 2800 w. Trans of Am Soc of Mech Engs, No. 799—Nov., 1898. No. 24241 D.

Regulations.

The New Saxon Regulations for the Prevention of Accidents with Water-Tube Boilers. Ch. Bellens. Translated from *La Revue Technique*. The regulations promulgated by the Technical Commission appointed by the province of Saxony, and put into effect Dec. 18, 1897. 2000 w. Power—Nov., 1898. No. 23788.

Smoke.

The Reduction of the Smoke Nuisance in Locomotive and Other Boilers. (Verminderung der Rauchplage bei Lokomotiv und Anderen Kesselfeuerungen.) A paper read before the German Railway Society with especial reference to the Langer and Marcotty steam-jet system for improving combustion in locomotive boilers. 6000 w. Glaser's Annalen—Nov. 1, 1898. No. 24120 D.

Steam Dynamo.

Three-Thousand Horse Power Direct-Driven Steam Dynamo at the Station of the Edison Company, Brooklyn, N. Y. Illustrated detailed description of features deserving special mention. 1500 w. Power—Nov., 1898. No. 23787.

Steam-Engine Practice.

Some Points in Modern Steam-Engine Practice. Henry Hodgson. Abstract of paper read before the Manchester (Eng.) Assn. of Engs. Gives the writer's views as to the best type of steam-engine for general use, discussing details. 2500 w. Eng's Gaz—Nov., 1898. No. 23874 A.

Steam Generation.

The Generation and Utilization of Steam by the Lykens Valley Coal Company and Summit

Branch Coal Company, Dauphin County, Pa. R. Van A. Norris. Report of investigations made for the purpose of discovering and remedying a large discrepancy in the amount of coal used for firing at two collieries. Illustrations, maps, and tables are given. 5000 w. Trans of Am Soc of Mech Engs, No. 796—Nov., 1898. No. 24238 D.

Steam Pipes.

Experiments on the Flow of Steam Through Pipes. R. C. Carpenter. Describes experiments made to determine the coefficient of friction of steam flowing at different velocities through pipes and fittings. 3800 w. Trans of Am Soc of Mech Engs., No. 806—Nov., 1898. No. 24246 D.

Valve Diagram.

Bilgram's Diagram and the Solution of Problems Involving Lead. Merrill Van G. Smith. Showing that one of the fundamental problems involving lead, cited in Prof. Fox's recent article on the Zeuner Diagram, can be solved by a simple and exact construction quite as simple as by the Zeuner diagram. 500 w. Jour Fr Inst—Nov., 1898. No. 23828 D.

Valve Gear.

Valve Gear of the Willans Engine. John Svenson. Comments on the characteristics of this gear and a statement of its leading advantages. Ill. 1800 w. Trans of Am Soc of Mech Engs, No. 797—Nov., 1898. No. 24239 D.

Winding Engines.

Safety Appliances for Winding Engines. States the requirements common to all safety appliances, and describes the chief appliances in use, including the Römer, Baumann, Müller, Hahn (Münzner), and Jetschim apparatus, comparing the systems and giving conclusions. Ill. 5000 w. Col. Guard—Nov. 11, 1898. No. 24053 A.

MISCELLANY.

Address.

American Society of Mechanical Engineers—Annual Address of the President, 1898. C. W. Hunt. A discussion of engineering practice, industrial progress, and the work of an engineer, with its effect on mind, character and life. 5400 w. Trans of Am Soc of Mech Engs, No. 807—Nov., 1898. No. 24247 D.

Brewery.

The New Castillo Hermanos Brewery in Guatemala. (Neue Brauerei von Castillo Hermanos in Guatemala). C. W. Schüitz. Description and plans of large brewery plant designed in Germany for erection in Guatemala, and representing the latest German practice. 1800 w. Zeitschr d Ver Deutscher Ing—Oct. 29, 1898. No. 24108 D.

Graphical Methods.

Graphical Methods for the Reduction of Experimental Observations. W. F. Durand. Brief discussion of some of the ways in which results may be treated, calling attention to the methods most readily applicable. 1800 w. Sib Jour of Engng—Nov., 1898. No. 23988 C.

The Application of Graphic Interpolation in Machine Design. Adolph S. Ostreicher. Describes a method showing how tables can be directly completed without involving the design of each size individually nor sacrificing correctness. Ill. 1100 w. Engr, Lond—Oct. 28, 1898. No. 23867 A.

Inventors.

The Beneficent Inventor. An editorial on the progress due to the inventor, and the blessings conferred on humanity, and the essentials of success. 3000 w. Engng—Oct. 28, 1898. No. 23860 A.

Liquefied Gases.

The Liquefaction of Gases. Raymond Jerry, in *Revue Encyclopédie Larousse*. A review of the researches in this field, and the most recent results. Ill. 4000 w. Sci Am Sup—Nov. 19, 1898. No. 23977.

Moment of Inertia.

The Theory of the Moment of Inertia. C. V. Kerr. States the fundamental ideas underlying the theory, gives a comparison of results from analytical and graphical methods for the purpose of showing the correctness of the methods used, and the salient features of this form of the theory. 5000 w. Trans of Am Soc of Mech Engs, No. 793—Nov., 1898. No. 24235 D.

Type-Setting.

The Cox Type-Setting Machine. Illustrated detailed description. 1100 w. Engng—Nov. 18, 1898. No. 24273 A.

MILITARY ENGINEERING.

American Ordnance.

American Naval Ordnance and Armor in the Late War. The report of Capt. Charles O'Neill shows the number of vessels supplied with munitions of war, and that most of the material came from the United States. Other related matters are noted. 900 w. Eng News—Nov. 10, 1898. No. 23886.

Armor Plate.

Cammell's Krupp Process Plate. Illustrated account of the trials of this plate at Shoeburyness, and recording another success in the manufacture of thick Krupp process armor. 1500 w. Engr, Lond—Nov. 11, 1898. No. 24063 A.

Krupp Armor—Its Application to Defeat Shell Fire in Warships. A discussion of recent makes of Krupp armor, the alterations that have been made in applying armor to vessels, and some things learned from the Santiago fight. 2000 w. Engr, Lond—Nov. 4, 1898. No. 23944 A.

Test of a Bethlehem-Krupp Armor Plate. Official report of tests recently made at the Redington proving grounds, with results. 500 w. Ir Age—Nov. 24, 1898. No. 24098.

Battleships.

American-Built Warships for the Russian Navy. Illustrations of the vessels, with details of their construction and equipment. 1700 w. Sci Am—Nov. 5, 1898. No. 23763.

The French Battleship "Charles Martel." Some particulars of this vessel, with general view, and two page plate of a section of her main engines. 300 w. Engng—Oct. 28, 1898. No. 23859 A.

Launch of the First-Class Battleship Formidable. Describes the vessel and its equipment, giving special illustrations showing various features. 2000 w. Engng, Lond—Nov. 18, 1898. No. 24270 A.

Launch of the Japanese Battleship Shikishima. Illustration and description of the vessel and its equipment and a brief account of the launching. 2000 w. Engr, Lond—Nov. 4, 1898. No. 23951 A.

The French Battleship Bouvet. An illustrated description of the largest and finest iron-clad at present in the French navy. 900 w. Engr, Lond—Nov. 4, 1898. No. 23947 A.

Boats.

The Standard Navy Boats. Arthur B. Cassidy. A very fully illustrated account of the standard small boats for the United States Navy, including ships boats, steam cutters, and dinghies. 3000 w. 38 plates. Trans Soc N A & M E—1898. No. 24250 F.

Cruiser.

Electrical Equipment of the U. S. Cruiser "Newark." E. W. Countiss. An illustrated description of the electric plant recently installed. 2800 w. Am Elect'n—Nov., 1898. No. 23739.

H. M. S. Diadem. Illustrated description with dimensions and particulars of the vessel, equipment and armament. 2500 w. Engr, Lond—Oct. 28, 1898. No. 23869 A.

H. M. S. Hyacinth. Describes the twin-screw, wood-sheathed, steel protected cruiser just launched 1200 w. Engr, Lond—Oct. 28, 1898 No. 23871 A.

H. M. S. Pactolus. Particulars and report of preliminary trials, just successfully completed. 1500 w. Engr, Lond—Oct. 28, 1898. No. 23870 A.

Destroyers.

Torpedo Boat Destroyers for the United States Navy. Illustrated description of the vessels of this class ordered for the U. S. navy, with particulars of the engines, and criticisms of the designs. 3500 w. Engr, Lond—Oct. 21, 1898. No. 23723 A.

Torpedo-Boat Destroyers. G. W. Dickie. A paper presented before the Society of Naval Architects and Marine Engineers, giving detailed description of a torpedo-boat destroyer, designed with especial reference to the conditions which prevail on the Pacific coast of the United States. 2500 w. 1 plate. Trans Soc N A & M E—1898. No. 24249 F.

Explosives.

High Explosives and Smokeless Powders and their Applications in Warfare. Hudson Maxim. Reviews the attempts made to produce smokeless powder, the success with small arms, the importance of a smokeless cannon powder, and the production of the Maxim-Schüpphaus powder. 5000 w. Jour Fr Inst—Nov., 1898. Serial. 1st part. No. 23829 D.

The Manufacture of Explosive Compounds. Perry F. Nursey. Part first discusses gunpowder and gun-cotton and describes the methods of manufacture. 2000 w. Ind & Ir—Nov. 4, 1898. Serial. 1st part. No. 23937 A.

Fireproofing.

The Fireproofing of Wood for the New United States Battleships. A description of the method of preparation, with information concerning the actual fireproofness, durability and strength. Ill. 2200 w. Eng News—Nov. 17, 1898. No. 24001.

Flash Signals.

Long Distance Signals from Free or Captive Balloons. (Les Signaux à Grandes Distances à Bord des Aérostats Captifs ou Libres.) M. Dibos. A system of flash signals based upon the use of phosphine generated from calcic phosphide. The details are carefully worked out and illustrated. 2600 w. La Rev Tech—Nov. 10, 1898. No. 24172 D.

Gunboats.

Construction of the New U. S. Composite Gunboats with a Comparison of Their Performances. Illustrations, dimensions, particulars, and trials. 1500 w. Marine Engng—Nov., 1898. No. 23834 C.

New British gunboats "Dwarf" and "Thistle." Describes boats of an interesting type, designed with special reference to the requirements on river service in distant British possessions. 1000 w. Engng—Oct. 28, 1898. No. 23862 A.

Guns.

The New High Powered Guns of the Vickers, Sons & Maxim Company. An illustrated description of the gun, giving an explanation of the device for preventing erosion and stating the advantages of the new mechanism. 1800 w. Sci Am—Nov. 5, 1898. No. 23764.

H. M. S. Diadem.

Boilers and Engines of H. M. S. Diadem. Engraving of engines and drawings showing most of the fittings of the boilers, with brief description. 500 w. Engr, Lond—Nov. 11, 1898. No. 24065 A.

Monitors.

The Proposed New Monitors. Illustrated description of the designs now rejected, of the harbor defense vessels ordered by Congress. To be followed by the amended designs. 1300 w. Sci Am—Nov. 12, 1898. No. 23892.

Naval Evolutions.

Use of Curves of Space and Velocity in Evolutions. (Impiego delle Curve degli Spazi e delle Velocità nei Cambiamenti di Distanze o d'Intervalli e nelle Evoluzioni in Generale) G. Como. The author argues for the closer study of graphical methods in the Italian navy. 7000 w. 2 plates. Rivista Marittima—Aug-Sept., 1898. No. 24192 H.

Naval Operations.

Official Report on the Naval Operations in the West Indies. A chronological abstract of Secretary Long's report of Sampson's fleet, which describes the naval operations before Cuba which ended in the destruction of Cervera's fleet. Chart. 7800 w. Sci Am Sup—Nov. 12, 1898. No. 23896.

Navies.

The Navies of the World. An article on the British navy, dealing with the battleships and armored cruisers. The first of a series on the subject named. Ill. 3000 w. Sci Am—Nov. 26, 1898. Serial. 1st part. No. 24084.

Rifle.

The Springfield Rifle. D. W. Flagler. An interesting discussion from the annual report of the Chief of Ordnance, concerning the relative merits of the Springfield rifle and the magazine gun. 1500 w. Ir Age—Nov. 24, 1898. No. 24099.

Torpedo Boats.

Department Plans for Torpedo Boats and Destroyers for the U. S. Navy, Recently Contracted For Gives the essential elements of design stipulated, with plans of engines, and list of contracts let. 3000 w. Marine Engng—Nov., 1898. No. 23835 C.

War Ships.

Designs of the New Vessels for the U. S. Navy. Philip Hichborn. A full description of the new vessels for the U. S. Navy, including battleships, monitors, torpedo-boats and destroyers, with tables of data and many large folding plates giving the full drawings of the vessels. A most important paper. 5000 w. 27 large plates. Trans Soc N A & M E—1898. No. 24255 H.

Yachts.

The Steam Yacht as a Naval Auxiliary. W. P. Stephens. A paper before the Society of Naval Architects and Marine Engineers, giving a very complete account of the composition and performance of the auxiliary fleet of steam yachts in the U. S. navy during the Spanish war. 4500 w. 9 plates. Trans Soc N A & M E—1898. No. 24254 F.

MINING AND METALLURGY.

COAL AND COKE.

American Coal.

See Economics and Industry, Commerce.

Arkansas.

The Bonanza Arkansas Coal Mines. H. Foster Bain. Notes gathered during a recent visit. A semi-anthracite coal of high steaming value. The means of working are described 1500 w. Eng & Min Jour—Nov. 12, 1898. No. 23910.

Bavaria.

The Development of the Coal Fields of Upper Bavaria. (Das Oberbayrische Kohlenvorkommen und Seine Ausbeute.) L. Hertle. A discussion of the geological conditions and practical workings of the coal fields of upper Bavaria, with data of the industrial and commercial results. 4500 w. 1 plate. Glückauf—Oct. 29, 1898. No. 24134 B.

California.

Tesla Coal Mines. F. J. Horsewill. A large coal property in Alameda Co., California, which has recently been developed. Particulars as to its location, the position of the seams, the methods employed in working them and the plant for preparing and handling the coal. Ill. 3300 w. Mines & Min—Nov., 1898. No. 23743 C.

Coal Dust.

Methods of Dealing with Coal Dust. Discusses the methods used at the various stages of the work, and all the points of importance in connection with the work. Ill. 3300 w. Col Guard—Oct. 21, 1898. No. 23727 A.

Coal Industry.

See Economics and Industry, Commerce and Trade.

Continental Europe.

The Coal and Coke Industries of Continental Europe. Part first begins the review of these industries in Germany. 900 w. Ir & Coal Trds Rev—Oct. 21, 1898. Serial. 1st part. No. 23725 A.

Preparation.

Improvements in Preparation. (Neuerungen in der Aufbereitungen.) V. Waltl. Describing and illustrating recent improvements in machines for washing and preparing coal. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 22, 1898. No. 24132 B.

Novelties in Coal-Preparing Machinery. V. Waltl in *Oesterreichische Zeitschrift für Berg- und Huttenwesen.* Illustrated description of washers and draining grid. 1200 w. Col Guard—Oct. 28, 1898. No. 23866 A.

Subsidence.

Subsidence Caused by Colliery Workings. Joseph Dickinson. A discussion of this paper, read at the June meeting of the Manchester (Eng.) Geological Society. 2200 w. Col Guard—Nov. 11, 1898. No. 24057 A.

Subsidence Caused by Colliery Workings. Joseph Dickinson. Read before the Manchester (Eng.) Geological Soc. Explains the methods for computing the extent of subsidence, the areas for support, and other details of the subject. 3200 w. Col Guard—Oct. 28, 1898. No. 23864 A.

Survey.

Geological Survey of South Wales and Monmouthshire. A. Strahan. Read before the British Assn., at the Bristol meeting. An explanation of the work and the revision of the coal fields. 2500 w. Col Guard—Nov. 4, 1898. No. 23939 A.

Weathered Coals.

The Calorific Power of Weathered Coals. R. S. Hale and Henry J. Williams. Tabulated results of analyses with statement of the conditions. The results show a slight diminution of calorific power directly traceable to weathering. 900 w. Trans of Am Soc of Mech Eng, No. 798—Nov., 1898. No. 24240 D.

Wedge.

A New Wedge Process as a Substitute for Explosives. (Eine Neue Keilvorrichtung zum Ersatze der Schiessarbeit.) Describing the use of a combined screw and wedge tool for use in breaking down coal in mines in which explosives cannot be permitted. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 5, 1898. No. 24133 B.

New Wedge for Coal-Getting. From *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Describes an improved wedge and its manner of working. Ill. 900 w. Col Guard—Nov. 11, 1898 No. 24055 A.

COPPER.

Lake Superior.

The Boom in Lake Copper Mining. Brief account of the great activity in this industry. The mines of the lake country are valued at $105,000,000. 1200 w. Ir Age—Nov. 24, 1898. No. 24097.

Manufacture.

The Converter in Copper Manufacture. P. L. Barthe, in the *Annales des Mines.* Illustrates and describes an apparatus devised by Paul David, called the "selecteur," and its working. 1800 w. Ir & Coal Trds Rev—Nov. 11, 1898. No. 24061 A.

Ore Deposits.

The Occurrence of Copper and Lead in the San Andreas and Caballo Mountains. C. L. Herrick. Describes the region and the conditions prevailing. 2500 w. Am Geol—Nov., 1898. No. 23907 D.

Refining.

See Electrical Engineering, Electro-chemistry.

Smelting.

Copper-Matte Smelting in Chili. Henry Watson. Some information concerning the furnaces of Panulcillo. 800 w. Aust Min Stand—Oct. 6, 1898. No. 23880 B.

Wyoming.

The Wyoming Copper Region. J. C. Kennedy. Describes this deposit, its location, development, and various mines. Ill. 1700 w. Eng Rec—Nov. 26, 1898. No. 24228.

GOLD AND SILVER.

Alaska.

Mining Conditions in Alaska. "Alex. Quartz." Discussing the seeming decline of the mining industry and explaining some of the causes. Claims that it is not from lack of gold in its mines, but the hard conditions imposed by the government. Gives encouraging reports of some districts recently explored. 2500 w. Min & Sci Pr—Nov. 12, 1898. No. 23999.

Alluvial Deposits.

The Glacial Epoch.—Its Relation to Alluvial Gold Deposits. L. O. Beal. Reviews the evidence of glaciation, and gives his own opinion in explanation of the ice movement. Illustrates the means by which alluvial gold was gathered and re-distributed, and other geological work. Ill. 3500 w. Aust Min Stand—Oct. 20, 1898. Serial. 1st part. No. 24071 B.

Amalgamating.

Notes on a Laboratory Amalgamating Device and Comparisons with Actual Mill Results. H. A. Guess. Illustrates the device, explaining the necessities that led to its adoption and outlining the method used in determining the milling value. 1100 w. Can Min Rev—Oct. 31, 1898. No. 23767 B.

Arizona.

Mining in Yavapai County, Arizona. John F. Blandy. Some notes on the development work of this field. 900 w. Eng & Min Jour—Nov. 5, 1898. No. 23803.

Coolgardie.

The Coolgardie Contract. Relating to the project for furnishing a water-supply to this gold-mining district in western Australia. The way it is proposed to solve a difficult problem. 2000 w. Ir & Coal Trds Rev—Nov. 4, 1898. No. 23954 A.

Cyanide.

Discrepancies in Slime Treatment. Discussion and correspondence on the paper of W. A. Caldecott. 4300 w. Jour of Chem & Met Soc of S. Africa—Sept., 1898. No. 22846 E.

Loss of Gold in Cyaniding by Volatilization. Matt. W. Alderson. An account of the writer's work and his investigations of the effect of oxygen in connection with the dissolution of the gold by cyanide. 3500 w. Min & Sci Pr—Oct. 29, 1898. No. 23789.

Dredging.

Dredging for Gold. J. B. Jaquet. Official report of the industry in Otago, N. Z. Ill. 2500 w. Aust Min Stand—Sept. 22, 1898. Serial. 1st part. No. 23879 B.

Klondike.

The Cost of Production of Gold and the Klondike Fields. Discussing whether the cost of obtaining the gold is not greater than the profit. 2300 w. Bankers' Mag, Lond—Nov., 1898. No. 23849 C.

New Zealand.

Gold Mines in the New Zealand West Coast Districts. (Mines d'Or de la Nouvelle-Zélande, District de la Côte Ouest.) Illustrated description of the district, its geology, and principal mines. 4400 w. Le Génie Civil—Oct. 22, 1898. No. 24155 D.

Treatment of Gold Ores in the Hauraki Peninsula, New Zealand. A. H. Bromly. Describes some typical plants of this district, and gives general information. 2500 w. Eng & Min Jour—Nov. 12, 1898. No. 23909.

River Deposits.

The Buried Rivers of California as a Source of Gold. J. R. Scupham. How these rich and peculiar formations have been preserved. Modern instances of similar volcanic action covering river beds. Some particulars in regard to the returns which have been made by drifting on the ancient bed rock. 4000 w. Mines & Min—Nov., 1898. No. 23745 C.

Russia.

The Present Conditions of Gold Mining in the Kochkara Region in the Oural. R. Helmhacker. Part first is mainly descriptive of the geological features. 1500 w. Min & Sci Pr—Nov. 5, 1898. Serial. 1st part. No. 23992.

Utah.

The Chloride Point Mine, Utah. Description, with illustration, of this silver mine, which was pronounced worthless, but by methods of handling the low-grade ores, has proved of value. 1200 w. Eng & Min Jour—Nov. 19, 1898. No. 24027.

Tintic, Utah.

The Mines of Tintic, Utah. Don Maguire. The largest and one of the most productive silver, lead and copper regions in the state. A description of the situations of the various mines, the formations in which they are found, the extent of their development and the amount of their production. 3500 w. Mines & Min—Nov., 1898—No. 23747 C.

Transvaal.

The Transvaal Fields. Report of increasing yield but decreasing prosperity, with extracts from published articles, giving comments on reports, expenses, &c. 1200 w. Aust Min Stand—Sept. 22, 1898. No. 23878 B.

Washington.

The Republic Mine, Washington. M. H. Joseph. An illustrated description of this first mine of a promising district. 1600 w. Eng & Min Jour—Nov. 5, 1898. No. 23802.

IRON AND STEEL.

American Iron.

See Economics and Industry, Commerce and Trade.

Iron and Steel.

See Economics and Industry, Commerce and Trade.

Iron Ore.

Iron Ore and Pig Iron Production in 1897. Statistics for the United Kingdom compiled from the General Report on Mines and Quarries. 1300 w. Col Guard—Nov. 18, 1898. No. 24280 A.

Prospecting.

Magnetic Methods of Prospecting for Iron Ores in Sweden. From a report on the mining industry of Sweden, 1897, by Prof. Nordenstrom, describing the instruments employed and the methods of using them. Ill. 2800 w. Mines & Min—Nov., 1898. No. 23744 C.

Sheet Iron.

Note on the Manufacture of Sheet Iron. (Note sur la Fabrication des Toles). Hubert Bya. This paper is limited to the discussion of sheets more than 2½ millimetres thick. The processes are fully described and numerous figures are given. The article is an interesting and valuable review of the present state of sheet metal manufacture on the continent of Europe. One plate. 8000 w. Rev Universelle des Mines—Sept., 1898. No. 24179 G.

Steel.

Influence of Arsenic upon the Mechanical Properties of Steel. (Etude sur l'Influence de l'Arsenic sur les Propriétés Mécaniques de l'Acier.) J. Marchal. The conclusion is drawn from the results of numerous experiments, that the small percentages of arsenic met with in steel have practically no effect upon its working qualities. 1400 w. Bulletin de la Société d'Encouragement—Oct., 1898. No. 24177 G.

MINING.

Explosives.

High-Pressure Steam as a Substitute for Explosives in Coal Mines. H. Schaw. Abstract of a paper taken as read at the Birmingham meeting of the Inst. of Min. Engs. Suggests that a cartridge of pure water, lodged in a shot-hole be converted into steam by means of electricity. 700 w. Col. Guard—Oct. 21, 1898. No. 23729 A.

Firedamp.

Firedamp Disengagements and Barometric Variations. Herr Bellmann, in *Glückauf*. Abstract translation. A report of observations recorded, and particulars of explosions. 1400 w. Col Guard—Oct. 21, 1898. No. 23828 A.

Haulage.

Haulage in Mines. Llewellyn M. Evans. Essay awarded second prize in contest. A comparison of the methods of underground haulage used in the anthracite mines of Pennsylvania. 3300 w. Mines & Min—Nov., 1898. No. 23748 C.

Head Frames.

Steel Head Frame for the Philadelphia & Reading Coal & Iron Co.'s Mines at Gilberton, Pa. W. L. Cowles. Illustrated description of the most recent practice in this line. 800 w. Eng News—Nov. 10, 1898. No. 23884.

Lamps.

The Sussman Mine Lamp. (Note sur la Lampe de Mines du Système Sussman.) Ad. Abrassart. Illustrated description of the ingenious dry accumulator of Sussman and its application to various systems of mine lamps, also of the mechanism used in charging large numbers of these lamps at once. 4000 w. Rev Universelle des Mines—Sept., 1898. No. 24181 G.

Mine Transmission.

See Electrical Engineering, Transmission.

New South Wales.

The Mining Industries of New South Wales. An account of the various minerals and metals found, and the value of the deposits. 1400 w. Jour Soc of Arts—Oct. 28, 1898. No. 23816 A.

Pumping.

A Mammoth Electric Pumping Plant. Illustrates and describes the largest electrical pumping plant in the United Kingdom—at the Gorebridge Collieries. 1700 w. Col Guard—Nov. 4, 1898. No. 23953 A.

Details of Deep Well Pumps--Geological Conditions in England. W. H. Booth. Showing how English practice differs from American, and the conditions affecting it. 1200 w. Am Mach—Nov. 24, 1898. No. 24095.

Hydraulic and Electrical Pumps for Mines. Translated Abstract from *Glückauf.* Illustrates and describes these types. 1700 w. Ir & Coal Trds Rev—Oct. 21, 1898. No. 23726 A.

Pumping-Station at Sierra Almagrera. Gustave Charles Reinhold. Contributed to the Inst. of Civ. Engs. (England). This line of hills is in South-east Spain, and reaches a height of 3000 ft. above sea level. Describes the scheme of the various mining companies for the drainage of this region, giving illustrations of the work. 5700 w. Col Guard—Nov. 11, 1898. No. 24059 A.

Respiratory Apparatus.

New Respiratory Apparatus for Use in Mines. From *Le Génie Civil.* Gives a brief description of the Fleuss apparatus, and describes two new types recently adopted in Austria-Hungary. Ill. 2300 w. Sci Am Sup—Nov. 19, 1898. No. 23976.

Road Curve.

A Mine Road Curve. George W. Engel. Describes an interesting device by which much time and expense are saved and capacity for hoisting coal increased. Ill. 900 w. Mines & Min—Nov., 1898. No. 23746 C.

Safety Catches.

Bley Safety Arrangements for Mine Cages. Illustrates and describes the safety apparatus adopted at the collieries of Florentin, Kaestner & Co., Reinsdorf, near Zwickau, Saxony, giving tabulated results of five trials carried out in the testing frame, or tower. 1800 w. Col Guard—Nov. 4, 1898. No. 23938 A.

Safety Stop for the Briart Guide. (Parachute pour Guidonnage Briart.) Ch. Marbais. Illustrated description of a simple safety stop for mine cages or other hoistways where the Briart rail guides are used. 1000 w. Rev Universelle des Mines—Sept., 1898. No. 24180 G.

Timbering.

The Stability of Certain Woods for Mine Timbering. C. Dütting. From a paper read before the Munich Mining Congress. An account of investigations to establish the value of beech props, to ascertain the suitability of acacia wood, and to determine whether preservative substances can be employed with advantage. 4000 w. Col Guard—Oct. 28, 1898. No. 23863 A.

Tunnelling.

Tunnelling by Cross Cut and on the Vein in Metal Mines. Arthur Lakes. Discussing its advantages and uncertainties. Circumstances where a cross-cut should not be run and where it may be profitable, and some notable instances of each. Ill. 3000 w. Mines & Min—Nov., 1898. No. 23749 C.

Tunneling on the Mother Lode. W. C. Ralston. Description of work and report of cost of tunneling by the Melones Mining Co. in the Mother Lode in Calaveras Co , Cal., with comparison of cost of tunneling at the Hogsback mine in Placer Co., Cal. Ill. 1800 w. Min & Sci Pr—Nov. 5, 1898. No. 23993.

Ventilation.

Determination of a Fan's Efficiency by Guibal's Conception of the Temperament. Gustave Hanarte. From a communication to the Société des Ingenieurs du Hainaut. Gives methods for ascertaining the useful work given out by a fan, which in the author's opinion permit the testing of the various types. Ill. 3300 w. Col Guard—Nov. 18, 1898. No. 24281 A.

Testing Ventilators with the Aid of an Opening to Free Air. (L'Essai des Ventilateurs à l'Aide d'un Guichet à l'Air Libre.) S. Hanappe. A long analytical discussion of the whole subject of the movement of air in mine galleries and the finding of the equivalent orifice for a given mine section. 10,000 w. Rev Universelle des Mines—Oct., 1898 No. 24183 G.

The Useful Work of Mine Fans and Method of Observing It. Gustave Hanarte, in a communication to the Société des Ingenieurs du Hainaut. Describes the trial at the mine and the conditions. 2800 w. Col Guard—Nov. 11, 1898. No 24056 A.

Water.

Observations on the Sudden Influx of Water from Large Springs. (Beobachtungen Eigenthümlicher Auftriebserscheinungen der Wasser Grösserer Quellengebiete) F. W. Klönne. With especial reference to the influx of water into the mines at Dux, Bohemia, from adjacent springs. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 15, 1898. No. 24131 B.

Winding Engines.

See Mechanical Engineering, Steam Engineering.

MISCELLANY.

Belgium.

Belgian Mineral Statistics for 1897. Emile Hargé. Report of the Directeur-Général des Mines. 2000 w. Col Guard—Oct. 21, 1898. No. 23730 A.

China.

British Mineral Concessions in China. A résumé of the meeting of the Pekin Syndicate held in London, with other statements in regard to the Shansi concessions. 1800 w. Col Guard—Nov. 18, 1898. No. 24277 A.

Diamond Mines.

The Kimberly Diamond Mines. (Note sur l'Exploitation des Mines de Diamants à Kimberly.) Albert Bordeaux. Treats of the geology of the region, describes the principal mines, method of extracting and treating the rock, and gives a table of diamond production for eight years. 2 plates. 7000 w. Rev Universelle des Mines—Sept., 1898. No. 24178 G.

Graphite.

The Graphite Deposits of Passau. (Ueber die Graphitlagerställen der Umgebung von Passau.) E. Weinschenk. An illustrated account of the important Bavarian graphite deposits near Passau and Silberberg. 2000 w. 1 plate. Glückauf—Nov. 5, 1898. No. 24135 B.

Lead.

A Proposed New Method of Smelting Lead Concentrates. Henry F. Collins. Outlines a process which he calls a roast-reaction process. 2500 w. Can Min Rev—Oct. 31. 1898. No. 23768 B.

Manganese.

The Manganese Ores of Brazil. (Les Manganèses du Brésil.) Miguel Ribeiro Lisboa. A very full account of the location of these ores, their composition, method of mining, and exploitation. 9000 w. 1 plate. Rev Universelle des Mines—Oct., 1898. No. 24182 G.

Metallurgy.

See Electrical Engineering, Electro-chemistry.

Nickel.

The Extraction of Nickel from Its Ores by the Mond Process. Prof. Roberts-Austen. Abstract of paper read at meeting of the Inst. of Civ. Engs. (England). Describes the experiments which led to this method, and the satisfactory results. 1100 w. Col Guard—Nov. 11, 1898. No 24058 A.

The Mining, Smelting and Refining of Nickel. Titus Ulke. A detailed account of a variety of processes in use in various places, giving data of costand with special reference to the electrolytic refining method and the saving of valuable by-products. 2500 w. Engineering Magazine —Dec., 1898. No. 24291 B.

Onyx.

The Onyx-Marbles. Courtenay De Kalb. An explanation of the term, the requisite qualities, preparation and cost, localities where deposits are found and other information. 3800 w. Stone—Nov., 1898. No. 24013 C.

Ore Deposits.

Ore Deposits Near Coolac, New South Wales. Describes a district presenting interesting features in connection with its ore deposits. 1300 w. Aust Min Stand—Oct. 6, 1898. No. 23881 B.

Petroleum.

The Illuminating Value of Russian Petroleum. Dr. M. Albrecht's defense of Russian petroleum, in reply to an unfriendly article published in Hamburg. 1300 w. Am Mfrs & Ir Wld—Nov. 4, 1898. No. 23837.

Precious Stones.

How to Identify Precious Stones. Leopold Claremont. Abstract of article in the London *Mining World.* Reviews the various tests usually applied, advising that the prospector be guided by the result of all, as a single test is apt to mislead. 1400 w. Eng & Min Jour—Nov. 19, 1898. No. 24028.

Salt.

The Manufacture of Salt Briquettes at the Royal Salt Works at Salzkammergut. (Ueber Sudsalzbriquettirung bei den k. k. Salinen des Salzkammergutes.) Max v. Arbesser. With illustrations of the hydraulic presses, and detailed description of the process. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 28, 1898. No. 24117 B.

Soda Deposits.

Occurrence and Treatment of the Carbonate of Soda Deposits of the Great Basin. S. A. Knapp. Information concerning these extensive deposits in the western United States, and their increasing economic importance. 2000 w. Min & Sci Pr—Nov. 5, 1898. No. 23994.

Surfusion.

Surfusion in Metals and Alloys. W. C. Roberts-Austen. Abstract of a paper read at the Royal Society, May 26, 1898. Reviews the results of investigations from this point, and experiments made, and gives the method adopted by the author which gives evidence as to the identity of the behavior of saline solutions and metallic alloys as regards selective surfusion. 900 w. Nature—Oct. 27, 1898. No. 23819 A.

Turkey.

The Useful Minerals of Turkey. R. Helmhacker. Reports the country rich in mineral wealth although the production is small. Gold, silver, copper, lead, antimony, arsenic, sulphur, chrome ore, manganese, iron, emery, salt, soda, coal &c., are found. 3300 w. Eng & Min Jour —Nov. 26, 1898. No. 24227.

United Kingdom.

The Output, Value and Distribution of Coal in 1897. Statistics and detailed particulars relating to the distribution of coal, compiled from the General Report on Mines and Quarries. Map. 1800 w. Col Guard—Nov. 18, 1898. No. 24276 A.

Uranium.

Uranium. A. Selwyn Brown. Relates the discovery of this mineral, giving such information as has been obtained, and some of the uses to which it is applied. 1500 w. Aust Min Stand—Oct. 20, 1898. No. 24072 B.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Automatic Feed Acetylene Generator. (Appareils Cousin à Chute Automatique de Carbure.) Illustrated description of an acetylene generator which feeds the carbide automatically. 500 w. La Rev Tech—Oct. 25, 1898. No. 24169 D.

The Acetylene Installation for Lighting the City of Wabash, Ind. Brief account of a plant that is to replace the artificial gas system. The gas is piped through the streets and sold by meter, and is thus far a success. 1000 w. Am Gas Lgt Jour—Nov. 28, 1898. No. 24263.

The Present Position of Acetylene Lighting. Abstract translation of a lecture by Dr. Paul Wolff of Berlin, published in *Zeitschrift für Angewandte Chemie.* Part first considers cost of production, the difficulties to overcome, cause of explosions, &c. 2500 w. Jour Gas Lgt—Nov. 8, 1898. Serial. 1st part. No. 23998 A.

Birmingham, Eng.

The Extension Scheme of the Saltley Gas-Works, Birmingham, Eng. An account of the work now in progress and the further extensions to be made. 3000 w. Jour Gas Lgt—Oct. 18, 1898. No. 23710 A.

Burner.

The Self-Mixing Gas Burner. Particulars and engravings from *Revue Industrielle.* Describes the new apparatus of M. L. Denayrouze. 1600 w. Sci Am Sup—Nov. 26, 1898. No. 24086.

Combustion.

Combustion in Retort Furnaces. Otto Pfeiffer. Abstract translation from the *Journal für Gasbeleuchtung.* Describes observations made, giving results. Ill. 2000 w. Jour Gas Lgt—Nov. 1, 1898. No. 23877 A.

Gas Undertakings.

The Purchase of Gas Undertakings. Frank Balfour Browne. Notes the tendency to pass to municipal bodies the undertakings that have gained success through private capital, and discusses questions which were raised in connection with the Morley case in England. 2500 w. Jour Gas Lgt—Nov. 8, 1898. No 23997 A.

Illuminating Power.

The Loss of Illuminating Power of 25- to 30-Candle Gas when Mixed with Air. E. G. Love. Read at Oct. meeting of the Am. Gas Lgt. Assn. Calls attention to a few points in connection with the deleterious action of air on coal-gas. Discussion. 2800 w. Pro Age—Nov. 1, 1898. No. 23769.

Leakages.

Localizing Leakages. W. Binse Randall. Read at meeting of the So. Dist. Assn. of Gas Engs. and Managers. Describes a method found to be economical and satisfactory. 2000 w. Gas Wld—Nov. 12, 1898. No. 24049 A.

Leeds, England.

Inclined Retorts at Leeds. An account of a visit of inspection to the gas-works, and the opening of the new retort-house. 3500 w. Gas Wld—Oct. 22, 1898. No. 23712 A.

The Development and Extension of the Leeds Gas Undertaking. An account of a municipal gas undertaking whose policy has been rewarded by marked success, the extension of the works, new inclosed retort house, &c. 4000 w. Jour Gas Lgt—Oct. 25, 1898. No. 23850 A.

Light Extinctions.

Sudden Extinctions of Artificial Light. Norton H. Humphreys. Notes on what may be done in the way of guarding against failures, and the value of a safety bye-pass governor in gas distributing plants. 2300 w. Jour Gas Lgt—Nov. 15, 1898. No. 24091 A.

Longton, England.

New Gas-Producing Plant at Longton, Eng. Description of new works with plan. 1500 w. Jour of Gas Lgt—Oct. 25, 1898. No. 23851 A.

Mains.

Notes on Mains and Main Laying. Walton Forstall. Read at meeting of Am. Gas Lgt. Assn. Discusses weight of pipe, methods of connecting and laying, special work, &c., giving an appendix and discussion. Ill. 10,500 w. Am Gas Lgt Jour—Nov. 14, 1898. No. 23963.

Naphthalene.

Extended Experience with the Hastings Carburation Process for the Prevention of Naphthalene Deposits in the Distributing Mains and Services. Charles E. Botley. Read at meeting of the So. Dist. Assn. of Gas Engs. and Managers, England. A brief description of the process, with report of extended experience. Also discussion. 6300 w. Gas Wld—Nov. 12, 1898. No. 24048 A

Prepayment Meters.

Slot Cookers and All About Them. E. W. T. Richmond. Shows the penny-in-the-slot device to have been known before the Christian era, briefly considers the modern applications, and sketches the history of the prepayment system in connection with automatic meters and the growth of gas-cookers in this connection. Ill. 3600 w. Jour Gas Lgt—Nov. 15, 1898. Serial. 1st part. No. 24090 A.

Use of Gas.

How Can We Make the Use of Gas More Universal? A discussion of the paper of Henry L. Doherty at the Niagara meeting of the Am. Gas Lgt. Assn. 6500 w. Am Gas Lgt Jour—Nov. 7, 1898. No. 23845.

Water-Gas Setting.

Depth of Fire in a Water-Gas Set. J. M. Rusby. General consideration of the subject with report of special tests, and discussion. 2800 w. Pro Age—Nov. 15, 1898. No. 23966.

SEWERAGE.

Sewage Disposal.

Sewage Disposal at Chorley, England. Illustrated description of a plant using ferozone precipitation and polarite filters. 1000 w. Eng Rec—Nov. 26, 1898. No. 24222.

The Biolysis of Sewage. Describes the theory of the Scott-Moncrief cultivation tanks and the new apparatus to replace filters in purifying the effluent. 1500 w. Eng Rec—Nov. 26, 1898. No. 24223.

Sewage Pump.

An Automatic Sewage Lift, Salem, N. J. An illustrated description of plant operated by water from street mains. 700 w. Eng Rec—Nov. 5, 1898. No. 23796.

Sewer Flushing.

The Effect of Flushing Devices for Small Sewers. Illustrated description of valuable experiments in Washington. 2500 w. Eng Rec—Nov. 12, 1898. No. 23924.

Sewer Flushing. Review of new method, by J. H. Fuertes, for determining the flushing power of discharges of different volumes in sewers of different grades. 1000 w. Eng Rec—Nov. 26, 1898. No. 24214.

Ventilation.

The Ventilation of Sewers and Drains as a Source of Diphtheria. James Aitken. Extracts from experts showing that when sanitary improvements have caused a decrease of ordinary diseases, they have frequently been accompanied by an increase of diphtheria. Ill. 1400 w. San Rec—Oct. 28, 1898. No. 23818 A.

STREETS AND PAVEMENTS.

Asphalt.

The Manufacture of Asphalt Pavements. A statement of the method of producing hard or soft pavements by changes in the process of manufacture. 1100 w. Eng Rec—Nov. 19, 1898. No. 24015

Denver, Colo.

Notes on the Sewers and Pavements of Denver, Colo. A description of comparatively recent work. 700 w. Eng News—Nov. 10, 1898. No. 23885.

London Streets.

Inaugural Address of J. Wolfe Barry. Discusses London traffic with reference to the proposed and suggested new streets and improvements. Map. 10,000 w. Jour Soc of Arts—Nov. 18, 1898. No. 24272 A.

London Streets and the Traffic. Editorial discussion of the address of J. Wolfe Barry. 1500 w. Engng—Nov. 18, 1898. No. 24274 A.

Paving.

A Study of Paving Materials. An analysis of the value of different pavements, by G. W. Tillson, made by representing an ideal pavement as having 100 per cent. of value and ascribing to each property of such a pavement a certain percentage of influence. The relative merits of each actual paving material expressed in the same manner, enable its advantages for any given street to be discussed. 3500 w. Eng Rec—Nov. 26, 1898. No. 24224.

WATER SUPPLY.

Cincinnati, O.

The California Pump Pit, Cincinnati Water-Works. Illustrated description of a circular caisson, 129 ft. in diameter, 20 ft. high, and 12¼ ft. thick in the roof. 900 w. Eng Rec—Nov. 12, 1898. No. 23922.

Cisterns.

Tank and Cistern Construction. Information intended to facilitate the designing of tanks and cisterns suitable for the positions they are to occupy. Considers the strains they are subject to, leakage, &c. 3300 w. Builder—Nov. 5, 1898. No. 23960 A.

Filtration.

Filtration and the Water Supply of Cities and Towns. Deductions drawn from investigations made at various places to determine whether the methods applied to large water plants, afford the desired protection. 1300 w. Sci Am—Nov. 12, 1898. No. 23891.

Grafton, W. Va.

The Grafton, W. Va., Water-Works. Illustrated description of a plant stated to represent standard practice for small works. 600 w. Eng Rec—Nov. 19, 1898. No. 24022.

Ground-Water.

The Level of Ground-Water Supply. (Grundwasserspiegel bei Brunnenanlagen.) Dr. P. Forchheimer. An elaborate mathematical discussion of the variations in the level of ground water, when the source is drawn from wells for water supply. Two articles, 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 4, 11, 1898. No. 24118 each B.

Philadelphia.

Politics and Engineering in Philadelphia. A report of the attacks on the Chief of the Bureau of Water made in the interests of private water companies. 800 w. Eng Rec—Nov. 5, 1898. No. 23795.

Pumping-Engine.

Triple-Expansion Pumping Engine at Ogdensburg, N. Y. Charles A. Hague. An illustrated detailed description of a low-duty triple-expansion engine recently installed in the water-works of the city named, and representing the most advanced practice of this type. 2000 w. Eng News—Nov. 24, 1898. No. 24200.

Purification.

Chemical Purification of Potable Water. From *La Nature*. Describes the method recently proposed by Prof. Lapeyrere that permits of effecting nearly absolute sterilization. The process has been utilized in the manufacture of a small pocket-filter by MM. Delsol & Fillard. 1500 w. Sci Am Sup—Nov. 19, 1898. No. 23978.

Lessons From the Louisville Experiments on Water Purification. Editorial on the value of experimental work, the careful investigations of mechanical filters at Louisville, and similar work at other places. 2800 w. Eng News—Nov. 10, 1898. No. 23887.

Reservoirs.

Special Features of the Reservoirs at the Cambridge, Mass., Water-Works. Illustrates and describes the overflow and aerating chambers of the Hobbs Brook reservoir, and the gate-house, and asphalt lining of the Payson Park reservoir. 600 w. Eng News—Nov. 24, 1898. No. 24201.

San Francisco.

San Francisco Water Supply. Illustrates and describes the municipal system of artificial storage, giving explanation of the climatic and other conditions prevailing. 1800 w. Sci Am—Nov. 19, 1898. No. 23974.

Submerged Main.

Ellis Island Submerged Water Main. Description of a 5,100 ft. main 6 ins. in diameter laid in New York harbor. 1300 w. Eng Rec—Nov. 26, 1898. No. 24221.

Tonawanda, N. Y.

The North Tonawanda, N. Y., Water-Works. T. W. Barrally. Illustrated description of a new plant with an unusual protective intake pier, riveted steel intake, and about 16 miles of wood distributing mains. 2200 w. Eng Rec—Nov. 12, 1898. No. 23923.

Water-Meters.

Popular Errors About Water-Meters. John C. Trautwine, Jr. Statements correcting popular errors in regard to the object sought by using meters, giving quoted correspondence from various cities and towns showing their value in checking waste. Ill. 2800 w. Pro of Engs Club of Phila, No. 67—Nov., 1898. No. 23986 C.

Water Rates.

The Basis of Water Rates. Review of decision of the California Supreme Court based on a recent decision of the U. S. Supreme Court, as to the method of computing fair water rates to be charged by a local company. 1100 w. Eng Rec—Nov. 5, 1898. No. 23793.

The Chillicothe Water Rates Case. Review of a decision of the Missouri Supreme Court as to the meaning of a schedule of meter rates in a charter of a private water company. 1400 w. Eng Rec—Nov. 19, 1898. No. 24017.

MISCELLANY.

Convention.

The Convention of the American Society of Municipal Improvements. An account of the meeting with abstracts of papers on sewers, pavements, street extensions, electrolysis, &c. 6000 w. Eng Rec—Nov. 5, 1898. No. 23799.

Disinfecting.

Disinfecting Stations. Reviews a recent book by Samuel Rideal, giving brief abstract of chapter on the subject named. 1400 w. Builder —Nov. 12, 1898. No. 24042 A.

Drainage.

Modern Drainage Inspection and Sanitary Surveys. Gerard J. G. Jensen. Part first gives a brief illustrated description of some of the most reliable apparatus for making tests for hidden defects with the mode of application. 600 w. San Rec—Nov. 18, 1898. Serial. 1st part. No. 24271 A.

Fire Protection.

The Fire Protection Apparatus at the Charlottenburg Exhibition. (Die Feuerwehrtechnischen Maschinen auf der Ausstellung in Charlottenburg) Wilh. Geutsch. Devoted especially to aerial ladders and similar apparatus for the use of municipal fire departments. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing —Oct. 29, 1898. No. 24109 D.

Rubbish.

The Removal of House Rubbish. (Die Beseitigung des Hausmülls.) An account of the Kinsbruner system in which the closed bodies of the collecting carts are made removable for the better delivery of the rubbish to the barges. 1200 w. Gesundheits-Ingenieur—Oct. 31, 1898. No. 24128 B.

Sanitation.

The Reconstruction of Plague-Stricken Cities in India. A. J. Hughes. Presents the great importances of these problems, the difficulties, and an explanation of the character of the enterprises now in progress for dealing with this subject. 6300 w. Engr, Lond—Nov. 11, 1898. No. 24062 A.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in September. Detailed list with classified summary. 4300 w. R R Gaz—Nov. 4, 1898. No. 23784.

Comparative Travel.

Railway Travel in Europe and America. Benjamin H. Ridgely. Gives the conditions of travel on the continent of Europe, comparing with American accommodations, with illustrations of some of the car arrangements. 5800 w. Ry Age—Nov. 4, 1898. No. 23838.

Fast Runs.

A Remarkable Run on Great Western Railway. Charles Rous-Marten. Reports the particulars of a fast run on a British railway, at the average rate of 58.7 miles an hour. 1600 w. Engr, Lond—Nov. 4, 1898. No. 23943 A.

Fast Run on a French Railway. (La Marche d'un Rapide au Chemin de Fer du Nord.) Description with diagram of speeds and profile of track between Paris and St. Quentin. The average speed was 62.7 miles per hour over a distance of 95 miles, the train weighing 178 tons. 1000 w. La Rev Tech—Nov. 10, 1898. No. 24171 D.

Fast Runs on the Wabash. Notes the changes recently brought about on this railroad, and gives records of runs, and particulars relating to them. 800 w. Ry Age—Nov. 11, 1898. No. 23928.

Freight Checking.

The "Vericheck" System of Checking and Loading Freight. Describes the system devised by Charles T. Banks, which has proved successful in active practice, giving a copy of the instructions. 2500 w. Ry & Engng Rev—Nov. 12, 1898. No. 23964.

Japan.

A Journey to the Tenth Annual Railway Congress of Japan. Willard C. Tyler. An interesting account of this journey, describing the equipment, customs, and railway management. 1800 w. Ry & Engng Rev—Nov. 26, 1898. Serial. 1st part. No. 24265.

Trains Breaking.

Trains Breaking in Two. The methods of investigating trains parting used on the Nashville, Chattanooga and St. Louis is explained. 1200 w. Ry Age—Nov. 18, 1898. No. 24035.

Wrecking.

Recovery of Two Locomotives from the River Adour. (Relevage de Deux Machines Tombées dans l'Adour, à Tarbes.) Interesting short illustrated description of method and tackle employed in the salvage of the locomotives. 400 w. Le Génie Civil—Oct. 15, 1898. No. 24153 D.

FINANCIAL.

Abandonment.

Abandonment of the Carbondale and Honesdale Gravity Railroad. Gives briefly the history of this road, one of the oldest in the world. Ill. 1500 w. R R Gaz—Nov. 18, 1898. No. 24007.

Auditing.

Duties of the Traveling Auditor. J. Shirley Eaton. Extracted from the *Railway Agent and Station Agent.* States briefly the personal qualities and preparation desirable, and considers the duties and manner of fulfilling them. 2400 w. Ry and Engng Rev—Oct. 29, 1898. No. 23742.

Bonding.

The Canadian Bonding Privilege. Condensed from an article in the *Toronto Globe.* Discusses the traffic through Canadian territory, and the comparative Canadian traffic through the United States, and the effect if the Canadian Pacific and the Grand Trunk should be placed under the Interstate Commerce Act. 1700 w. R R Gaz—Nov. 25, 1898 No. 24209.

British Railways.

British Railway Returns. Editorial on the Board of Trade return for the year ending Dec., 1897. The traffic is unprecedented both in volume and revenue. 1500 w. Engng—Oct. 21, 1898. No. 23732 A.

Earnings.

Net Railway Earnings for Nine Months. Report showing the tendencies of earnings of the various groups of roads as compared with corresponding periods. 1200 w. Bradstreet's—Nov. 19, 1898. No. 24026.

India.

The East Indian Railway Report for Latter Half of 1897. Comment and statistics based on the latest report of the Board of Directors of the East Indian Railway, which show a prosperous year in spite of the plague and famine. 800 w. Ind Engng—Oct. 1, 1898. No. 23821 D.

LEGAL.

Interstate Commerce.

The Interstate Commerce Commission's Demands for More Power. M. H. Smith. A discussion of the additional powers desired by the commission, as shown in the Cullom bill, claiming that not one will tend to correct the rate demoralization. 2500 w. R R Gaz—Nov. 18, 1898. No. 24005

Smoke Nuisance.

Indictment of Railroad Companies for Nuisance. Editorial commenting on the recent indictment of the Long Island Railroad Co. for the smoke nuisance. 1300 w. R R Gaz—Nov. 11, 1898. No. 23906.

MOTIVE POWER AND EQUIPMENT.

Dump Car.

The Goodwin Dump Car. Illustrates and describes the most recent type of this car, used for handling and dumping material for railroad work. 800 w. Eng News—Nov. 17, 1898. No. 24000.

Dynamometer Car.

A New Dynamometer Car. Illustrated description of a car built by the C. C. C. & St. L. Ry and equipped by the University of Illinois for the mutual advantage of both parties. 800 w. R R Gaz—Nov. 25, 1898. No. 24208.

Gondola Car.

Four-Wheeled Gondola Car, Delaware & Hudson Canal Co. Illustrates the construction of a car rapidly disappearing from use, but once the standard cars for the conveyance of coal. 800 w. R R Car Jour—Nov., 1898. No. 23913.

Locomotive Boiler.

See Mechanical Engineering, Machine Works and Foundries.

Locomotive Efficiency.

Locomotive Efficiency and Capacity. C. A. Seley. Discusses the advance in capacity, and how brought about, and the compound non-condensing principle as applied to locomotives. 1200 w. Loc Engng—Nov., 1898. Serial. 1st part. No. 23781 C.

Locomotives.

A Run on a Four-Cylinder Engine. Describes the performance of an English locomotive, known as No. 720. 1200 w. Engr, Lond—Nov. 4, 1898. No. 23949 A.

Compound Consolidation Pusher Engine; Lehigh Valley R. R. Illustrates and describes an engine with a guaranteed hauling capacity of a 1000 tons of train load behind the tender at an average speed of 17 miles per hour, on a mountain cut-off. 400 w. Eng News—Nov. 24, 1898. No 24205.

Compound Express Passenger Locomotive for the Prussian State Railways. Two page plate and other engravings with dimensions. 250 w. Engng—Nov. 4, 1898 No. 23936 A.

Consolidation Locomotive—Chesapeake and Ohio Railway. A locomotive designed by W. S. Morris, for mountain service, is illustrated and described. 900 w. Ry Mas Mech—Nov., 1898. No. 23841.

Consolidation Locomotive for the Delaware & Hudson. Illustration and general dimensions of locomotive lately built by the Dickson Mfr. Co., of Scranton, Pa. 200 w. R R Gaz—Nov. 18, 1898. No. 24008.

Consolidation Locomotives for the Union Pacific. Illustration showing appearance, with a list of the principal dimensions of the simple locomotives. 450 w. R R Gaz—Nov. 18, 1898. No. 24010.

Experiments upon a Compound Express Locomotive. (Expériences Faites au Chemin de Fer du Nord sur une Locomotive Compound à Grande Vitesse.) F. Barbier. Discussion, with reproductions of indicator diagrams, of experiments lately made, with conclusions. 3000 w. Le Génie Civil—Oct. 15, 1898. No. 24151 D.

Express Engine, Great Eastern Railway. Illustrates and describes a powerful type of express locomotives intended particularly for fast seaside traffic. 150 w. Engr, Lond—Oct. 28, 1898. No. 23868 A.

Four Cylinder Express Locomotives. (Viercylindrige Schnellzugs-Lokomotiven.) Rolf Sanzin. A review of the various types of four cylinder engines which have been made since 1852, with a tabulated scheme of those which are at present in use. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 21, 1898. No. 24115 B.

Hayes' Ten-Wheel Locomotive. M. N. Forney. Illustrates and describes an engine built for the Baltimore & Ohio R. R. in the fifties. 1200 w. Am Eng & R R Jour—Nov., 1898. No. 23750 C.

Locomotive Design—The Working Stress of Materials. Francis J. Cole. The present article discusses piston rods. Ill. 1800 w. Am Eng & R R Jour—Nov., 1898. No. 23751 C.

New Locomotives for the South Eastern Railway, England. J. Pearson Pattinson. Principal dimensions with illustrated description. 500 w. R R Gaz—Nov. 4, 1898. No. 23785.

New Locomotive for Very High Speed. (Nouvelle Locomotive à Très Grande Vitesse.) F. Barbier. A criticism of the high-speed locomotive design of M. Thuile. 1700 w. Le Génie Civil—Nov. 5, 1898. No. 24162 D.

Recent Types of European and American Locomotives. A full page plate containing 63 designs, with description of each and general remarks on the tendency in America and Europe. 8000 w. Eng News—Nov. 10, 1898. No. 23888.

Results of Recent Practical Experience with Express Locomotive Engines. Walter M. Smith. Read before the Inst. of Mech. Engs. (England). Also editorial. An account of extensive experiments with the object of obtaining an idea of the fitness of five classes of engines to perform a given duty. 5800 w. Engr, Lond—Nov. 4, 1898. No. 23950 A.

Richmond Locomotives for Finland. Illustrated description of engines of foreign type built in the United States. 500 w. Loc Engng —Nov., 1898. No. 23780 C.

The Heilmann Electric Locomotive. Description of the electric locomotive presented five years ago, and also of the improved designs recently built. 1500 w. Eng News—Nov. 24, 1898. No. 24202.

The Largest Locomotive in the World. General description with illustrations of the locomotives for the Union railroad, connecting the works of the Carnegie Co. Also editorial discussion as to the value of monster locomotives. 3000 w. Engr, Lond—Nov. 11, 1898. No. 24064 A.

Tests on Four-Cylinder Locomotives. (Versuche mit Viercylindrigen Lokomotiven.) F. Leitzmann. A review of the tests on the high-speed four-cylinder compounds made by M. Barbier on the Northern Railway of France. Serial. Part 1. 5000 w. Zeitschr d Ver Deutschr Ing—Oct. 22, 1898. No. 24105 D.

The Two Heaviest Locomotives. Editorial comparison of the heaviest American locomotive with the heaviest locomotive in Europe. 700 w. R R Gaz—Nov. 25, 1898. No. 24211.

Private Train.

The French Presidential Train Built by the International Sleeping Car Company on the Occasion of the Czar's Visit to France. General description, with illustrations, and details of construction. 2000 w. R R Car Jour—Nov., 1898. No. 23911.

Repair Prices.

The Adjustment of Prices of Car Repairs. Editorial considering the difficulties of the problem. 1200 w. Am Eng & R R Jour—Nov., 1898. No. 23753 C.

Sleeping Car.

Canadian Pacific Sleeping Car. Plan, interior view, and description of very elaborate decoration, designed by a Parisian designer brought from France for the work. 1200 w. R R Car Jour—Nov., 1898. No. 23912.

Trucks.

Car Truck Construction and Repairs. J. C. Barber. Condensed from a paper presented at the Sept. meeting of the Northwest Ry. Club. Calls attention to features in which there is room for improvement, and discusses bolsters, center plates, bearings, etc. 1800 w. Eng News—Nov. 3, 1898. No. 23771.

NEW PROJECTS.

Alaska.

Railroad Building in Alaska. An illustrated account of the difficulties encountered. The present year will close with about 35 miles of road constructed. 1500 w. Ry Age—Nov. 11, 1898. No. 23929.

Chinese Railways.

The Pekin-Hankau Railway Contract. The text of the contract recently made between the director-general of the Chinese railways and the Belgian syndicate, for the construction of a road from Lou kon-chiao to Hankau. 2000 w. U. S. Cons Repts—Nov., 1898. No. 23814 D.

See also Economics and Industry, Commerce and Trade.

Congo.

The Congo Railway. Editorial, describing the geographical character of the country, the difficulties met in surveying the road, some peculiarities of the construction, etc. 2000 w. Engng—Oct. 28, 1898. No. 23861 A.

Ealing.

The Ealing and South Harrow Railway. A brief account of a new line to be constructed in England. 900 w. Engr, Lond—Nov. 18, 1898. No. 24268 A.

Recent Construction.

The New Railway Construction of 1898. A general survey of the new work of the year, in the United States, showing it to be the largest since 1892. 2800 w. Eng News—Nov. 17, 1898. No. 24003.

Russia.

Railroads in Russia. Gives interesting statistics of the growth of the Russian railroad system, commenting on the interesting features. 1200 w. R R Gaz—Nov. 11, 1898. No. 23903.

PERMANENT WAY AND FIXTURES.

Bridge Renewing.

Rapid Bridge Renewing on the Rock Island. Illustrates the progress and describes the method followed in replacing the bridge across Squirrel Creek, Colorado. 1000 w. Ry & Engng Rev —Nov. 19, 1898. No. 24076.

Chicago.

Concrete Masonry in Chicago Track Elevation. Illustrates and describes what is probably the largest use of concrete work in railway engineering that has ever been attempted. 2800 w. Ry & Engng Rev—Nov. 19, 1898. No. 24075.

Crossings.

Highway Crossing Gates. Report of the committee of the Assn. of Ry. Supts. of Brdgs. and Bldgs. The merits and disadvantages of the types in common use are discussed. 2000 w. Ry Age—Nov. 4, 1898. No. 23839.

Instrument.

The Equilibristat. Don J. Whittemore. Describes an instrument for determining, while riding over the road, the difference of elevation between the opposite rails, whether the outer rail on curves is properly elevated, and also for other track work. Discussion and correspondence. Ill. 6500 w. Jour W Soc of Engs—Oct., 1898. No. 23914 D.

Interlocking Signals.

*Study of Interlocking Mechanisms. (Etude sur les Enclenchements.) M. Descubes. A very elaborate illustrated study of the general subject of interlocking and an exposition of a method for determining secondary interlockings. A valuable paper. 14000 w. Rev Gen des Chemins de Fer—Nov., 1898. No. 24190 F.

Locating.

From Trade to Profession—Advances in American Railway Location. William G. Raymond. Part first is introductory to a series of papers whose purpose is to point out the advance in American railroad location to the dignity of a profession, and the fitness of American engineers for the work in China. 1200 w. R R Gaz—Nov. 25, 1898. No. 24206.

Paris.

Line from Courcelles to the Champ de Mars, Paris. Crossing of the Auteuil Line,—Construction of the Passy Tunnel. (Ligne de Courcelles au Champ de-Mars, à Paris. Traversée de la Ligne d'Auteuil.—Construction du Tunnel de Passy.) A. Dumas. Complete description of the work and methods employed. Elaborately illustrated. 4500 w. 1 large plate. Le Génie Civil—Oct. 29, 1898. No. 24158 D.

Rack Railways.

Swiss Rack Railways. (Les Chemins de Fer Suisses à Cremaillère.) Table giving data of all the rack railways in Switzerland, including permanent way, rolling stock and operation details, with short explanatory note. 1500 w. Le Génie Civil—Oct. 29, 1898. No. 24159 D.

Rails.

Further Studies on Steel for Rails. (Weitere Studien über Schienenstahl.) A very full investigation into the use of basic open-hearth steel for rails, with data and results of tests, microphotographs of etched sections, and diagrams of behavior in service. Serial. 1st part. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 4, 1898. No. 24119 B.

Shops.

New Shops of the C. H. & D. Railway. An illustrated description of the new car shops at Lima, Ohio. 800 w. Ry Mas Mech—Nov., 1898. No. 23842.

Signal.

The Payne Block and Train Order Signal. Describes and illustrates a signal that has been in operation for six months on the L. S. & M. S. Ry. 800 w. Ry & Engng Rev—Nov. 5, 1898. No. 23825.

Snow Fences.

Snow Fences in France. Illustrates and briefly describes the styles tried in different countries. 900 w. R R Gaz—Nov. 11, 1898. No. 23905.

Stations.

New Pennsylvania Passenger Station at Jersey City. Plan of the new building made necessary by the fire of last winter. 350 w. R R Gaz —Nov. 18, 1898. No. 24009.

New Railway Stations in Dresden. (Les Nouvelles Installations des Gares de Dresde.) Henry Martin. Elaborately illustrated and complete description of several new stations. 3500 w. Le Génie Civil—Nov. 12, 1898. No. 24185 D.

New Station of the Pennsylvania R. R. at Pittsburg, Pa. General plan and description of improvements about to be made at a cost of probably over $1,500,000. 900 w. Eng News —Nov. 17, 1898. No. 24004.

Terminal.

The Terminal Wharves at Ivry. (La Gare d'Eau d'Ivry.) Georges Leugny. Illustrated description of the terminus of the Orleans Railway at Ivry (France) with notes upon the franchise under which it is to be constructed. 2000 w. La Rev Tech—Oct. 25, 1898. No. 24168 D.

Track Elevation.

Track Elevation in Chicago. The first six papers of a series on this subject, giving illustrated descriptions of work on the C. & N. W. Ry., P. C. C. & St. L. Ry., I. C. Ry., C. M. & St. P. Ry., and C. B. & Q. Ry. 15,600 w. Jour W Soc of Engs—Oct., 1898. No. 23918 D.

Tunnel.

Through the Arlberg with Oil Fuel. Describes the arrangements made to guard against the dangers to the men employed on the trains, arising from fumes and smoke. The run from Landeck to Bludenz is described. 1700 w. Engr, Lond—Nov. 18, 1898. No. 24269 A.

TRAFFIC.

Fares.

Austrian Experience with Passenger Fares. From an account by P. F. Kupka, published in the Journal of the German Railroad Union.

Changes made and their effects are discussed. 2700 w. R R Gaz—Oct. 21, 1898. No. 23479.

Industrial Department.

The Industrial Department of the Seaboard Air Line. The Explanation of John T. Patrick, as to the object and present status of this work. 2000 w. R R Gaz—Nov. 11, 1898. No. 23904.

Joint Traffic.

The Gentlemen's Agreement—A Bit of History. An account of the beginning of the Joint Traffic Association, and its history. 1200 w. Ry Age—Nov. 11, 1898. No. 23927.

Mail Carrying.

Cost of Carrying Mail on the Southern Pacific. Testimony brought out at the hearing in San Francisco, before the committee appointed to investigate the postal service. 1400 w. R R Gaz—Nov. 18, 1898. No. 24011.

Military Traffic.

Military Traffic on the Long Island Railroad. An account of the manner of meeting the sudden increase of passenger and freight service required by the establishment of a camp at Montauk. 2000 w. R R Gaz—Oct. 14, 1898. No. 23339.

The War Work of the Long Island Railroad. An account of what was done to handle the troops at Camp Wikoff and Camp Black. 2200 w. Ry Age—Oct. 21, 1898. No. 23636.

Police.

A Railroad Police and Some of its Work. L. F. Loree. An address at meeting of the Railway Claim Agents. Gives an account of the trouble caused by people stealing rides, walking on track, and otherwise causing trouble to railroads, and of the police system maintained and its cost. 1800 w. R R Gaz—Oct. 14. 1898. No. 23342.

Pooling.

Different Views of Pooling. Editorial discussion of the differences in the positions of railroad traffic officers, commenting especially on the views of Milton H. Smith. 2000 w. R R Gaz—Nov. 25 1898. No. 24212.

Regulated Pooling. H. T. Newcomb. An examination of the conditions which it is proposed to exact as consideration for permission to pool traffic. 2200 w. R R Gaz—Nov. 4, 1898. No. 23786.

Russia.

Freight Traffic on Russian Railroads. Some information concerning the amount of freight. 400 w. U. S. Cons Repts—Nov., 1898. No. 23813 D.

Sleeping Car Rates.

Sleeping-Car Rates in America and Europe. Benjamin H. Ridgely. An interesting article giving a comparison of arrangements and rates in the United States and Europe, with related information. Ill. 6000 w. Ry Age—Oct. 28, 1898. No. 23704.

STREET AND ELECTRIC TRAMWAYS.

Berlin.

Combination Trolley and Conduit Electric Tramway at Berlin. (Tramway Électrique de Berlin à prise de Courant Tantôt Aérienne, Tantôt Souterraine.) Henry Martin. Full detailed illustrated description of the tramway and construction methods. 2000 w. Le Génie Civil. —Nov. 5, 1898. No. 24161 D.

The Berlin Electric Railway. (Die Elektrische Stadtbahn in Berlin.) A general illustrated account of the new local electric railway in Berlin, showing both the elevated and underground construction. Two articles, 3500 w. Schweizerische Bauzeitung—Oct., 22, 29, 1898. No. 24129 each B.

Checking Employes.

System of Collection of Fares and Checking Employés. A. F. Walter. Describes a system that has given satisfaction on the Allentown & Lehigh Valley Traction Co. 3200 w. St Ry Rev—Nov. 15, 1898. No. 24031 C.

Comparative Costs.

Comparative Costs and Profits of Cable, Electric and Horse Railway Operation in New York City. A transcript of the private cost sheets and other records of the Metropolitan Street Railway Co. giving a true comparison of the relative cost of operation of cable, electric, and horse railways. A very important paper. 3500 w. St Ry Jour—Nov., 1898. No. 23759 D.

Conduit Systems.

Electric Conduit Systems. W. L. Hedenberg. Reviews the various systems that have been tried, commenting on the degree of success attained and illustrating the types, and giving a brief account of the extensive construction of the N. Y. Metropolitan St. Ry. Co. 2700 w. Elec, N. Y.—Nov 23, 1898. No. 24087.

Convention.

Tenth Convention of the International Street Railway Association. E. A. Ziffer. An account of the meeting in Aug., 1898, at Geneva, Switzerland. Gives brief description of Geneva, its tramways, and the proceedings of the convention. Ill. 7000 w. St Ry Jour—Nov., 1898. No. 23758 D.

Cripple Creek.

Interurban Railroading at Cripple Creek. Illustrated detailed description of this three-phase system with current generated at high pressure, transmitted, reduced and converted. 1000 w. St Ry Jour—Nov., 1898. No. 23755 D.

Electric Locomotive.

The Paris-Lyons Mediterranean Co.'s High Speed Electric Locomotive. (Locomotive Electrique à Grande Vitesse de la Compagnie Paris-Lyon-Méditerranée.) M. Auvert. A very complete and elaborately illustrated description of the machine and account of tests. For the trials current was obtained from a large battery of accumulators hauled in a special car, but a conductor system will be used. All the levers and switches are handled by a compressed-air auxiliary system. 8000 w. Rev Gen des Chemins de Fer—Nov., 1898. No. 24189 F.

Electrical Survey.

An Electrical Survey in the Borough of Manhattan, New York City. A. A. Knudson. Investigations and facts showing results of stray current measurements between electric railways, underground pipes, etc., also results of tests on the Brooklyn Bridge. Ill. 5500 w. Trans Am Inst of Elec Engs—Oct., 1898. No. 24077 D.

English Systems.

English Electric Railroads. The first of a series of articles discussing recent developments. The present paper considers the Glasgow electric tramways. 1200 w. R R Gaz—Nov. 25, 1898. Serial. 1st part. No. 24213.

Honolulu.

Honolulu and Its Street Railways. Frank X. Cicott. An illustrated description of the tramways with brief reference to the general conditions of the place. 1400 w. St Ry Jour—Nov., 1898. No. 23760 D.

Ireland.

Irish Light Railways. Gives a map showing the positions of the various lines and summarizes the experience obtained from light railway construction in Ireland. 1600 w. Ry Wld—Nov. 10, 1898. No. 24044 A.

London.

The Central London Railway. Part first considers the route taken and some of the construction work, giving plans, maps, &c., and general remarks on the enterprise. 2000 w. Engr, Lond—Nov. 4, 1898. Serial. 1st part. No. 23946 A.

Mechanical Motors.

Application of Mechanical Motors to Tramway Traction. (Application des Moteurs Mécaniques à la Traction des Tramways.) Abstract of M. Ziffer's report on the subject to the Union Internationale des Tramways. It discusses all sorts of motors, electric, gas, steam, cables, compressed air, etc., with conclusions. 2800 w. Le Génie Civil—Oct 22, 1898. No. 24157 D.

Mountain Railway.

Mount Dore Electrically Driven Cable Railway. (Funiculaire du Mont Dore. Transport de Force par Courant Triphasé.) Illustrated detailed description of an interesting mountain railway in France. The cars are operated by a cable operated by an electric motor, power being derived from a neighboring waterfall. A large plate of detail drawings accompanies the article. 4000 w. La Rev Tech—Nov. 10, 1898. No. 24170 D.

New Zealand.

Possibilities for Electric Traction in New Zealand. Frank X. Cicott. Illustrates and describes the physical features of the islands, giving information of the intelligence of the people, the commercial importance, exports, and other matters of interest. 1400 w. St Ry Rev—Nov. 15, 1898. No. 24030 C.

Paris.

Preliminary Work on the Metropolitan (Underground) Railway, Paris. (Le Métropolitain de Paris. Travaux préparatoires en Cours d'exécution.) Description of methods of work, especially in the rearrangement of sewers, etc. Illustrations and one plate. 3500 w. Le Génie Civil—Oct. 22, 1898. No. 24156 D.

Philadelphia.

Organization and Operating Methods of the Union Traction Company of Philadelphia. An illustrated description of the plan of organization, power stations, distribution circuits, roadbed, rolling stock, etc. 5800 w. St Ry Jour—Nov., 1898. No. 23754 D.

Power Stations.

See Elect. Engineering, Generating Stations.

Special Cars.

Special Cars in Brooklyn, N. Y. Illustrates and describes some novel cars used on the Nassau Electric Railway, including an office car, tower car, two parlor cars, and a new type of convertible car. 1800 w. St Ry Jour—Nov., 1898. No. 23756 D.

Steel Ties.

Steel Tie Construction at Rochester, N. Y. Illustrates and describes a track construction in which old steel rails were used for ties. 500 w. St Ry Rev—Nov. 15, 1898. No. 24032 C.

Traction.

Mechanical Tramway Traction. Part first discusses the report of J. Allen Baker to the London county council, on this subject, and considers briefly the gas-power tram car. 1700 w. Jour of Gas Lgt—Nov. 1, 1898. Serial. 1st part. No. 23876 A.

Polyphase Traction. Editorial discussion of the relative merits of the competing systems, their disturbance effects, and engineering or economic value. 1500 w. Elect'n, Lond—Oct. 28, 1898. No. 24248 A.

Tramway.

Anderson's Tramway. An illustrated detailed description of this system as shown in the experimental line built at Leeds, Eng. 1300 w. Elec Eng, Lond—Nov. 4, 1898. No. 23958 A.

Cable versus Electric Traction in Newcastle. Important estimates prepared by W. N. Colam and Dr. John Hopkinson on the cost of installing and working cable and electric tramways in Newcastle. 10,000 w. Ry Wld—Nov. 10, 1898. No. 24047 A.

Electric Tramways of Monaco. Illustrates and describes this surface-contact system of electric traction, with the location and equipment. 2000 w. Ry Wld—Nov. 10, 1898. No. 24043 A.

Liverpool Corporation Electric Tramways. Illustrates and describes the new double bogie cars and their equipment. 1800 w. Ry Wld—Nov. 10, 1898. No. 24046 A.

Permanent International Tramway Union. (Union Internationale Permanents des Tramways.) Brief account of the meeting of this association at Geneva, and conclusions reached after discussion of several points of interest concerning electric traction. 1500 w. L'Electricien—Nov. 12, 1898. No. 24188 B.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Baldwin Locomotive Works, Burnham, Williams & Co., Philadelphia, Pa., U. S. A.=Record of Recent Construction, No. 8. Specifications and illustrations of simple and compound locomotives recently constructed for use in China, Colombia, Chile, Peru, Russia, and various parts of the United States and Canada.

Baxter D. Whitney, Winchendon, Mass., U. S. A.=Illustrated catalogue of special wood-working machinery, including surface planing machines, wood scraping machines, sawing, boring, and moulding machines, also gauge lathes and special chair-making machinery. A remarkably beautiful specimen of typography, engraving, and press work.

The Hoppes Manufacturing Co., Springfield, Ohio, U. S. A.=Catalogue of steam separators, oil eliminators, and exhaust and live-steam feed-water heaters, with illustrated descriptions, specifications, and prices.

J. A. Fay & Co., Cincinnati, Ohio, U. S. A.=Sheet folder of American wood working tools of every kind, showing the capacity of the concern for the complete equipment of wood working establishments.

The Jeffrey Mfg. Co., Columbus, Ohio, U. S. A. =Descriptive catalogue of the Jeffrey Columbian combined separator, bolter, and screen for bolting and screening cement.

Merrill Pneumatic Pump Co., Bound Brook, N. J., U. S. A.=Pamphlet catalogue describing the Merrill pneumatic pumping machinery for excavating liquids by use of compressed air, using a displacement pump operating without floats. A pneumatic differential piston pump is also illustrated and described.

Pneumatic Engineering Co., New York.=Pamphlet describing at length the Harris system of pumping by compressed air, operating without floats and acting by the direct pressure of the air upon the surface of the liquid. Applications to mine pumping, fire service, and water supply are shown.

The Standard Time Stamp Co., New York.= Catalogue of the standard automatic time stamp for recording the exact time of any transaction; with long list of testimonials from users in a great variety of trades.

B. F. Sturtevant Co., Jamaica Plains, Mass., U. S. A.=Neat little pamphlet describing and illustrating the removal of the chimney at the works of the manufacturers and the successful substitution therefor of the Sturtevant system of mechanical draft.

Hyatt Roller Bearing Company, Harrison, N. J., U. S. A.=Catalogue and price list of Hyatt flexible roller bearing, showing numerous applications, together with tables of dimensions of hangers and floor stands; also data of tests, and letters of commendation from users.

Felt & Tarrant Mfg. Co., Chicago, Ill., U. S. A.=Pamphlet catalogues (*a*) describing and illustrating the construction and operation of the comptometer, a mechanical computing machine; (*b*) showing the applicability of the comptometer to railroad accounting, with practical examples, and a list of testimonials from railroad men.

Westinghouse Machine Company, Pittsburg, Pa., U. S. A.=Beautifully illustrated catalogue of Westinghouse compound engine, with data of tests and description of details.

American Impulse Wheel Co., New York.= Descriptive catalogue of the "Cazin" impulse water wheel with illustrations of details and tables for weir measurements, heads, pressures and power.

The Globe Company, Cincinnati, Ohio, U.S.A. =Very complete catalogue of filing cabinets and business furniture, including the Globe Wernicke systems of filing correspondence, documents and records; also supplies for indexing and cataloguing by the card-index method.

William Oxley & Co., Tudor Works, Pendleton, Manchester, England.=Illustrated price-list of storage tanks plant and appliances for oils, varnish, and chemical manufacturers.

S. A. Daniell, Ltd., Edward street, Parade, Birmingham, England.=Price-list of engineers', gas and fitters stocks and dies, twist drills, braces, tube cutters and vices. Dimensions and usual particulars given.

Jessop & Appelby Bros., Ltd., 22 Walbrook, London.=Fully coded catalogue, entitled "Appelby's Illustrated Hand-book of Hoisting Machinery," with nearly 200 illustrations of all types of hoisting machinery, giving prices and very clear descriptive matter.

Rose, Downs & Thompson, Ltd., Old Foundry, Hull, England.=Catalogue of oil-mill machinery and grain-warehouse machinery; also of filter presses and hydraulic presses, disintegrators, and pumps. Fully coded, illustrated, and dimensioned.

A. & P. W. McOnie, Cessnock Engine Works, Glasgow, Scotland.=Handsomely-illustrated catalogue of sugar-cane crushing, evaporating, and refining machinery; also of rice and coffee machinery. Telegraphic code.

D. Stewart & Co., Ltd., London Road Iron Works, Glasgow, Scotland.=Illustrated catalogues (*a*) of electrical machinery, dynamos, arc lamps and electric light fittings; (*b*) of textile machinery for printing or bleaching works; (*c*) of engine and boilers; (*d*) of "Theisen's" evaporative condenser feed purifier and heater, with description of working.

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READINGS FROM EXPERIENCE IN NAVAL ENGINEERING.

By Engineer-in-Chief George W. Melville, U. S. N.

THE great successes of the United States navy in the recent war with Spain, notably the remarkable victories at Manila and Santiago, have aroused the pride of the people in the navy to a point which it had never reached before, so that they have been studying with considerable interest the elements which have contributed to that success. This has called attention to the fact, which has been pointed out repeatedly, that the war which has just ended might appropriately be called, as respects the navy, an engineer's war, using the term "engineer" in the broad sense, which includes the designers and manufacturers as well as the manipulators of the great fighting machine which the modern war-ship has become. It is eminently fitting, therefore, that the story of the war should include very prominently the part played therein by machinery, wherefore I am to treat here of the importance of steam engineering in naval warfare, and especially in the recent American victories.

When the steam engine first received a place in naval vessels, there was probably little idea that it would ever play the important part which it does now, as the machinery was considered, and actually was, auxiliary to sail power. The sole purpose of its installation upon the war-ship was to give facility in getting in and out of port and in manœuvring against unfavorable winds or in a calm. The highest speed was attained under sail, and the "weather gauge" in battle still depended largely upon the skill in handling sails. There was a good reason for this, the machinery being enormously heavy for the power developed, and consuming so much fuel that it was impossible to carry coal enough to move machinery of full power for even a few days. Nevertheless, the first step had been taken, and, as we now know, the problem was to increase economy and reduce weight.

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During the civil war in the United States, the country was fortunate to have, at the head of the engineering department of the navy, Commodore Isherwood, one of the most famous engineers which the country has produced, and a man who has made the whole profession of steam engineering his debtor. Assuming control at a time when the paddle-wheel engine was still largely used on war-vessels, the close of his administration saw the complete substitution of the screw-propeller. During his term of office the factors which limited large powers for machinery of war-ships were still controlling, as steam pressures and rates of rotation were still low, and the materials at the disposal of the designer were much inferior to those now available. Further than this, practically all the vessels were built of wood, and the engines were horizontal, so that rapid rates of reciprocation were inadmissible. Still another item has to be taken into account,—the fact that the United States navy was suddenly expanded to an enormous extent, necessitating the care of the machinery by a personnel the greater portion of which was untrained, and some portion of which was almost incompetent. It was necessary, therefore, that the machinery should be made heavier than sound designing would have dictated where proper care could have been assured. It must be remembered that, while light and economical machinery is, under normal conditions, the object to be attained, the purpose of a war vessel is to move with certainty, and Isherwood properly considered that, however perfect designs might be from the standpoint of the professor, the country would consider them failures if they broke down.

While considering the machinery of the civil war period, we must note the wonderful performance of the vessel which was Isherwood's greatest triumph, the Wampanoag. She was only one of a class designed with the special object of producing the fastest steamers in the world. She and the Ammonusuc were the only vessels of Isherwood's design which were tried, and both completely fulfilled expectations. The Wampanoag made a trial trip at sea in comparatively rough weather, lasting for thirty-eight hours, and for the whole trip averaged 16.6 knots. During several six-hour periods she averaged 17 knots, and the maximum speed was 17.75 knots. When it is remembered that she was designed about 1865 and tried in 1868, this performance is seen to excel anything in the history of marine engineering, for at that time the fastest vessels, either in the merchant marine or in the navy, did not make more than 13 knots. In fact, so great was this speed that it was not reached again in war vessels for more than a decade. Owing to the wooden hulls in which the machinery was to be placed, Isherwood adopted a type of engine which he, better than any one else, knew to be very heavy, but it enabled him with safety to put great power into the limber hull, and secured the result at which he aimed. The machinery of the Wampanoag consisted of two cylinders one hundred inches in diameter by forty-eight inches' stroke and running at thirty-one revolutions per minute for full power. The crank shaft was so geared to the propeller shaft as to give the latter sixty-three revolutions per minute. The horse power was slightly in excess of four thousand, and the steam pressure carried thirty-two pounds. The boilers were of the Martin vertical water-tube variety, and superheating boilers, in addition to the main boilers, were used, so that the expenditure of coal per horse power was 3.15 pounds—an economical figure for that day. The total weight of the machinery and water was 1,250 tons, or 3.24 i. h. p. per ton.

Shortly after the close of Mr. Isherwood's term of office, the compound engine was introduced into the United States navy, working at first with a steam pressure of about eighty pounds. Most of the vessels so fitted were small, and consequently high speeds were not attempted, the vessels of the Vandalia class, which were in their day very useful, having a speed of 12 knots with a displacement of about 2,000 tons. These were followed by the Trenton, which had a three-cylinder compound engine, but in which there was still no improvement in the weight of machinery per unit of power. From 1875 to 1883 there was a period of almost entire stagnation in the United States navy, work being confined almost exclusively to repairs, but then came the period of the advisory board and the vessels commonly known as the Roach cruisers. In these the pressures were increased to ninety and one hundred pounds, but there was still a very great weight per unit of power, none of these vessels being designed on the principle of high rotational speeds, introduced at about that period.

The vessel which really brought about the revolution in respect to speeds of rotation was the Esmeralda, of the Chilean navy, built by the Armstrongs in England in 1883; she for the first time surpassed the record of the Wampanoag, making a trial-trip record of more than 18 knots, although, as she was never run at full power for any long period, like the Wampanoag, it may be doubted whether she could have equaled that vessel's record for a period of the same length. The Esmeralda, besides having fast running engines, also used forced draft, which, within a few years preceding her trial, had gradually been re-introduced for fast vessels. The term "re-introduced" is used, because forced draft is really the invention of an American engineer, Mr. Edwin A. Stevens, and, as was pointed out by Mr. James Howden in 1893, Mr. Stevens practically used every form of forced draft with which we are now acquainted.

During the period since the introduction of the compound engine steam pressures had gradually been rising, making it possible to use a greater range of expansion, so that by this time the weight of machinery had been reduced and its economy increased, thereby justifying the use of large powers, especially as the use of wood as a hull material had been entirely abandoned, and the iron and steel hulls gave an amply strong foundation for the machinery used.

The next great step in advance was not long in coming,—namely, the introduction of the multiple-expansion engine by Dr. A. C. Kirk, of Glasgow. The first successful use of the triple-expansion engine was on the steamer Aberdeen in the merchant service, but very soon afterward Dr. Kirk proposed to the British admiralty to install triple-expansion engines in two vessels that he was building for them, designed originally for compound engines. The permission being granted, these vessels, the Australia and Galatea, ran successful trials in 1887, and since that time very few war vessels have been built with expansion at fewer than three stages.

We have now reached the point when the new United States navy began, and when several principles of correct design had been thoroughly established,—namely, high steam pressures, rapid rotation, forced draft for boilers, and a rigid inspection of material, making the scantlings a matter of close calculation, instead of a sort of refined guesswork disguised under the formula of large factors of safety.

It must be understood that many of the factors of improved design were so related that some were a natural consequence of others; this is notably the case with the improvement in material at the disposal of the designer. When it seemed that the limit had about been reached with wrought iron as the main reliance of the designer, mild steel had been so perfected as to enable progress to be maintained. The large boilers necessary to withstand the high pressures and furnish the power for high speeds would have been impossible but for mild steel, and the same thing is true of the moving parts of the engine. It may be noted also that workmanship had improved, and the use of anti-friction metals, combined with this improved workmanship, enabled the high speeds to be carried out with safety and reliability.

It has already been stated that the Wampanoag's machinery was so heavy that only 3.24 i. h. p. per ton of machinery was obtained. The San Francisco, one of the earliest of the modern cruisers of the United States navy in which advantage was taken of all the factors for reduction of weight, obtained 10.63 i. h. p. per ton of machinery.

It seemed for a time that further reduction of weight must depend upon the boilers, and, as forced draft furnished a ready means of burning any desired amount of coal, the designers who wished to be considered most progressive attempted to get a greater amount of power from a given amount of heating surface in the boiler. This, however, was not attended with success, and the experience of the British navy for a time was peculiarly unfortunate. In the United States navy, where the officials attempted to be progressive, while at the same time not being too radical, no attempt has ever been made to get a horse power from less than two square feet of heating surface. In some of the British vessels this figure was carried below one and one-half square feet, with the result that trial after trial was a failure, due to leaky tubes, and it was only after the adoption of what is known as the "Admiralty Ferrule" that the trials could be carried out even at reduced power.

There had been for many years a gradual increase in the size of ships, and with this increase of size there was an application of the law commonly known by the name of "Froude," although first announced by Reech, which in popular language may be expressed by saying that, for economy, big speeds belong to big ships. This fact is somewhat masked to the popular mind by the torpedo boats,—which are the fastest war vessels, although the smallest,—but a comparison of the Minneapolis, which made 23 knots, with the little Cushing, which made 22½, will show the difference in economy of power compared with displacement.

In the Minneapolis the speed of 23 knots was obtained with an expenditure of 2.84 i. h. p. per ton of displacement, while in the Cushing the corresponding figure is 16.7 i. h. p. The San Francisco class in the United States navy, which comprises four vessels, is of about 4,500 tons' displacement,—slightly larger than the Trenton, with an increase in speed of more than five knots. The Minneapolis and Columbia, of about 7,500 tons' displacement, were appropriately made faster vessels, the former making 22.8 and the latter 23.7 knots on their trials.

This question of speed is a vital one for the engineer, as it is the constant incentive to invention and improvement in design for the purpose of constantly reducing the weight per unit of power. Since vessels have become wholly dependent upon machinery for their propulsion, the "weather gauge" has become the highest sustained speed, and consequently the officers who are to command the ships are steadily demanding the highest speeds. This has led designers in every country to resort to every means to secure this end.

The growth of the factor which has caused the latest revolution in marine engineering—namely, the use of the water-tube boiler—has been very rapid in recent years. Water-tube boilers in some form are very old, not only on land, but at sea. Their use for large powers, however, is of recent date, and the United States may claim the earliest use of a large amount of power in water-tube boilers at sea—in the coast-defence vessel, the Monterey, in which such boilers, built by Mr. Charles Ward, for 4,800 i. h. p., were installed in 1891.

Boilers of this type had been used in the French navy for some years before this, but not for very large powers. For torpedo boats water-tube boilers had for some time been extensively used, and not very long afterward they entirely displaced the locomotive type. In France water-tube boilers of various types have entirely displaced the cylindrical boiler within the last few years, and the same is true of the English navy.

In the United States navy, after the installation on the Monterey, little was done until recently towards extending their use on ships of any size, and I trust I may be pardoned for a brief word of explanation in this connection, as my position in the matter may not have been thoroughly understood. The merits of the water-tube boiler have been so thoroughly set forth in this magazine and elsewhere that I need say only that, when these boilers were placed in the Monterey, I was fully aware of their advantages, but in the building of the navy the United States were in a different position from that of other countries. England and France, which were introducing the water-tube boiler so rapidly for large vessels, were adding to powerful fleets already in existence. The United States were building battle-ships for the first time, and I felt that, with all its advantages, there were certain disadvantages of the water-tube boiler which made it undesirable to adopt anything of an experimental nature in these few battle-ships, until the unqualified success of the new type of boiler had been demonstrated. In my annual report of last year to the secretary of the navy, I stated that, in my judgment, the time had arrived when it was perfectly safe to use water-tube boilers exclusively in all classes of vessels. At that time, besides the Monterey and all the torpedo boats, water-tube boilers were in use on the Nashville, Marietta, and Annapolis, and were being installed on the Chicago and Atlanta. Since that time all the designs from the bureau of steam engineering have been for water-tube boilers, and I consider that for war vessels the cylindrical boiler is now as definitely abandoned as the compound engine.

A word in passing may be given to some of the special advantages which water-tube boilers present for naval purposes. One is the great tactical advantage, which was very thoroughly brought out by the conditions of the blockade at Santiago,—namely, the quickness with which steam may safely be raised. In large cylindrical boilers steam can be raised from cold water in about three hours, but this is almost sure to injure the boilers by the unequal expansion. In water-tube boilers steam can be raised with perfect safety in half an hour or less, depending upon the size and type. To maintain vessels in readiness for instant use with cylindrical boilers fires must be kept in all the boilers, involving a large expenditure of coal, which in some of the ships on the Santiago blockade amounted to as much as thirty-five tons per day. With water-tube boilers this would not be necessary; a much smaller coal expenditure would suffice.

Another great advantage of water-tube boilers is the facility with which extensive repairs can be carried out without serious disturbance to the hull of the vessel. The Monterey's boilers were practically rebuilt a little more than a year ago by the force on board, without any change in the structure of the ship whatever. The most notable instance, however, occurred last summer, when three of the old monitors built during the war of '61-'65 had their old box boilers cut up and removed and new water-tube boilers installed. The pieces of the old boilers were passed out, and the parts of the new boilers were passed in through the smoke-pipe opening and assembled in place. Had any other than a water-tube boiler been put in, it would have been necessary to take up the whole deck over the boilers, and thus greatly delay the entrance of the vessel into service, whereas the water-tube boilers were in place and ready for steam in about thirty days after the contract for their building was placed.

The use of twin screws in naval vessels has been the rule so long that we are sometimes inclined to forget that it was not always so, and that this arrangement was a marked step in advance from a tactical standpoint, besides furnishing greater security against disablement.

A further step has been made in the use of triple screws on many vessels, the most notable of the early cases being the Columbia and the Minneapolis. The use of multiple screws dates back a considerable period, for what were known as the "tin clads" on the Mississippi during the United States civil war had four screws. The French were really the first to use triple screws for a large vessel, which they decided upon as a result of careful experiments on a steam launch. Before the Dupuy de Lome had been launched, when it was arranged to build for the United States two commerce destroyers, or "pirates," as they were familiarly called for a long time, it was decided to use three screws for constructive reasons, and with the idea that, for ordinary cruising, it would be more economical to run with a single screw than with two, on account of the fact that cruising power for one engine of three would form a larger percentage of its maximum power than it would in the case of each of the larger engines of twin screws.

When the Columbia and Minneapolis were tried, it was found, to the great astonishment of everybody, that apparently their economical performance was higher than that with twin screws. The determination of the speed was beyond question, and the accuracy of the power measurement was thoroughly verified, so that, whether the economy was due to the use of three screws or not, it is undoubtedly a fact that these two vessels showed a smaller horse power per ton of displacement at their maximum speeds than that shown by similar vessels with twin screws. That this economy is due to triple screws has been disputed, and it is claimed that tank experiments in England have demonstrated that there is no economy in the use of three screws rather than twins ; as a result, in the English navy no vessels have been built with triple screws. Exactly the opposite of this is true in France, Germany, and Russia, where nearly all the recent vessels of large power (more than thirty in number) have been built with triple screws, and it is probable that in the next lot of vessels the United States will adopt the same plan.

The results at Santiago showed that three screws have a tactical advantage over the other method, combining economy and great power where two sets of engines are placed on each shaft. The New York and Brooklyn are each fitted in this way, and on the day of the battle each was cruising with her forward engines uncoupled. There was not time to stop for coupling up the forward engines, which, moreover, were not warmed up and ready for use, and, as a result, the vessels could work only at half power. Had they been fitted with triple screws, the engines not in use could have been started as soon as they were warmed up, and thus full power would have been attained in a short time, even had all the engines not been in readiness at the moment of the sortie.

It may be remarked in this connection that triple screws would have many advantages for the high-speed merchant steamers now becoming common. The great advantage possessed by twin screws in the security against total disablement would be emphasized in the case of triple screws, as the breaking of the shaft would reduce the power only one-third instead of one-half. There would also be the great benefit of a reduction in the size of parts, as the engines now built are very large. It would be the greatest advertisement that any company could have, and would undoubtedly attract passengers. This is shown by the action of a prominent United States senator some years ago, who, after buying a return ticket and finding that it involved traveling on single-screw ships, disposed of it at a considerable loss, that he might go by a twin-screw vessel.

In another paper I shall discuss some of the lessons which were taught by the Spanish-American war, and also some other features of importance in the machinery of modern war vessels.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

II.—LABOR-SAVING MACHINERY AND LOW-WAGE-WORKERS.

THE idea is common on both sides of the Atlantic that American wages are high, and that most articles can be produced by European workmen more cheaply than by American. The common fallacy is to speak of wages as the sum of money received by labor for work covering a certain period of time. In reality wages are that reward which labor receives for a certain product. Wages are high when labor receives a large amount for that product; they are low when it receives a small amount for that product. In this latter sense American wages are the lowest in the world. One of the reasons that Americans are able to produce machine tools at a price which competes with that of the European article is that the wages paid for the same quality of product are less than those paid by the European manufacturer. This statement can be easily verified, and an examination of the conditions under which the machines are produced will show how it is accomplished.

In the production of machine tools, as well as other articles, Americans make use of labor-saving machinery as extensively as possible. As a natural result, a great deal of the labor on their machines is performed by the low-wage-worker. At the same time, the skilled worker earns more in a given time than his European brother. As in the manufacture of other articles, the idea in the production of machine tools, according to American practice, is to "machine" as close as possible to "finish dimensions," with as much accuracy as is attainable, and to allow very little for "fitting" or hand finish. The general European practice is the opposite of this, and it is customary to use machines simply for removing more or less metal,—not for working closely to finished dimensions,—leaving a large amount of work to be done by the so-called fitter. A good example of the latest American practice, in the above respect, is the results accomplished with the aid of the universal grinding machine. It is daily becoming more common to turn cylindrical parts only approximately to finished dimensions, taking little care to produce true or finished surfaces in the lathe. After it is roughed out, the work is put into the grinding machine, and ground truly cylindrical and exact to gauge, whether the part be hardened steel, soft steel, or cast iron. In many cases the workman who finishes the part does not see the piece into which it fits. The old "cut and try" method is largely done away with.

This reduces "fitting" to a minimum, and the result is a higher grade of work than can possibly be produced by the most skilful "turner," or lathe hand. By this system it is possible for the lathe attendant to be a comparatively unskilful operator, and to attend two or three machines taking heavy cuts and using fast feeds. The same is true of grinding work; one attendant can run two or three machines, simply working to limit gauges. As contrasted with these methods, the old way of turning nearly to size, and then filing to a fit, is still followed, with rare exceptions, in European shops. Of course, by the old method, work which is good and at the same time cheap cannot be produced. The system of sub-dividing work is carried so far in many American machine shops that the lathe hand is not allowed even to grind his own turning tools. The practice is rapidly extending of employing special machines for grinding lathe and planer tools. As fast as these tools need re-grinding, they are sharpened by one man,—not by any means a skilled workman, but one whose sole work is keeping tools of this particular class in proper cutting condition. Of course, a certain amount of skilled labor is and always will be necessary, but the practice followed by American machine-tool makers, who are now supplying a high-class article at a reasonable price, is to work, as far as possible, independently of the "craft," and to make use of well-paid tool-makers, who can produce jigs and fixtures by which parts can be cheaply and accurately manufactured.

In the production of cylindrical work, the turret machine is, as a labor-saving machine, now playing an important part,—particularly the flat turret lathe, and others which have been, more or less, inspired by the success of this tool. By the use of this machine, many parts, such as studs, short shafts, spindles, etc., can be produced at one-third or one-fourth the cost of lathe work, and it has been adopted by many manufacturers. As in other cases of labor-saving machinery, the operator is comparatively unskilled, but the machine should be under the control of a well paid tool-maker. It would surprise many makers of machinery to know for how small a number of parts, according to the makers of this machine, it will pay to "set up." The automatic screw machine is also being used to produce machine parts, although not extensively except for the production of screws. However, it is being so rapidly improved that it is sure to be more widely adopted, particularly by those who specialize and make in quantities.

Another interesting comparison of the methods employed, where labor-saving machines are used on the one hand and skilled labor is depended upon on the other, is in the finishing of cylindrical holes of small dimensions. This operation is known to the European manufacturer as "boring," and it is usually done either on a lathe of the ordinary type or on what is known as a surfacing and boring lathe. The tools for drilling, boring, and reaming are successively inserted in the same holding device,—either the tool post or the tail stock of the lathe. The operator must set the tools for each part, and must repeat the operation of setting and removing the tools as many times as there are pieces to be bored. This takes time, and calls for skilful manipulation. In American practice every well-regulated machine shop has what is called its "chucking" department. All articles requiring finished holes are sent to this department, which is fitted with machines known as turret-head chucking machines. These machines are arranged with special tools, which operate successively on the parts, the last operation being to finish the hole to size with an adjustable reamer. All work is kept to standard by limit gauges. With this method the tools are not removed from the machine until the required number of parts are "chucked." No time is lost in repeatedly setting up, and no skill is necessary on the part of the operator after the tools are once fixed. His wages average a dollar and a half per day, and he will turn out from two to three times more work than the best lathe hand earning from thirty-eight to forty-five shillings per week,—the average European wages for a good engineer. It will be seen that, in the ordinary machine shop, the bulk of this class of work can be done by low-wage operators. Skilled labor is called for only on the part of the tool-maker or foreman, who can easily keep in order eight or ten machines; his wages average perhaps three dollars per day, but, as they are distributed over a lot of ten machines, they add little to the cost of production. Not only is the work produced cheaper, but it has the usual advantages resulting from the use of labor-saving machinery; it is better work, of uniform quality, and can be done in one third the space which would be occupied if it was done on lathes. The general result is the development of a higher grade of workmanship, which makes interchangeability in machine-tool construction one of the near possibilities; in fact, this is already extensively carried out in the making of smaller machine-tool parts. Progress in one department makes progress possible, even compulsory, in other departments; as, for instance, when all holes are chucked to gauge, it is an easy matter for cylindrical parts to be finished to gauge, reducing fitting work to a minimum. Notwithstanding the fact that the above method offers many advantages, and that it has been in use for some time in American shops, properly equipped chucking departments are practically unknown in European workshops. There parts which must be turned on an arbor are, as a rule, finished outright by the lathe hand. He first uses his lathe as a boring machine,—for which it is not adapted. He then, for turning, uses the lathe,—which is very often spoiled in design by attempting to make it useful as a boring machine. After the part is turned, this lathe is converted into a polishing machine; emery dust surely does not add to its value as an accurate tool. This way of working gives variety, but not economy. Neither the machine or the worker can produce its best. Time is lost in constantly changing tools, and skill, which comes only from constant practice, cannot be acquired. Nearly all cylindrical work is included under the four operations, chucking, turning, grinding, and polishing. Machine shops should be so organized that these operations can be performed only in separate departments, by experts who do only one class of work, and on machines best adapted to the end in view.

Another contrast of methods may be observed in the finishing of flat surfaces. The European maker of machine tools has made but little application of the milling machine, and nearly all flat surfaces are reduced on the planer. It is well known that the planing machine requires the highest skill in its manipulation, if anything like accurate surfaces are desirable and expensive "fitting" is to be avoided. Consequently it is important to do away with planing as much as possible. The latest American practice is, in many cases, to rough-mill large surfaces on heavy milling machines, and then to finish these surfaces accurately with a light cut on the planing machine. By this method the removal of metal is accelerated three or four times, and seventy-five per cent. of the work is done by unskilled attendants. Small parts are finished outright on the milling machines, planing being done away with entirely; they are then made perfectly true on the surface grinder, one operator attending two or three machines; and a high finish is attained without any hand labor whatever, whether the material be cast iron, soft steel, or hard steel. With these methods a large part of the work of producing true flat surfaces can be done by low-wage machine attendants who run from two to four machines; the tool-maker is necessary, of course, to keep the machines in order, but, as in other cases, his higher wages are distributed over a group of machines. Of course, the most effective results are realized when this system is carried out on the largest scale, —as with the manufacturers of special lines, who are producing machine tools in limited varieties, but in large quantities. Even in small shops, however, and in those which make large varieties, all the above methods, common to American practice, could be introduced with success into European shops, thereby reducing the costs of manufacture and improving the quality of work.

The general tendency is for American manufacturers to reduce the great number of workers to low-wage attendants, to elevate a smaller number of skilled workers to a higher position with big wages, and to rely mainly on labor-saving machinery, not on a large number of average workers. The tendency in European machine shops is to maintain a large number of workers at a wage-rate not equal to the best, but perhaps a little in excess of that of the ordinary American operators, and to depend throughout on a class of skilled workers, instead of organizing the factory on labor-saving methods, investing in labor-saving machinery (which never goes on strike), and paying high wages to the few. Even to the uninformed observer, the number of "fitters" in the European machine shop is strikingly large as compared with the number of men doing hand work in the average American shop. Fitting can never be done away with entirely, and a certain amount of hand labor will always be necessary, but to work as near to the finished surface as possible with machinery, and to leave little for the fitter to do, is the aim of the American manufacturer, and it must be the aim of those who would compete with him. To deal with the influence which trade unionism has on the introduction of labor-saving machinery, particularly into English shops, would be but a repetition of facts known to all through the recent strike. It is sufficient to state that trade unions do not in the least affect the American maker of machinery, and the same is practically true of the German maker.

The use of labor-saving machinery, as practised by the Americans, has also the effect of reducing factory expenses, as it makes possible a better working system and organization, a sub-division of labor, and an exact inspection. Fewer operatives are necessary where automatic machinery is used, and, as parts are made in quantities, the cost-keeping is simplified and less office work is necessary. Where the work is reduced to "machine" operations, an extensive system of gauging becomes necessary, to which the unskilled operator must work. Not only is it possible to reach a higher degree of accuracy in single operations, but the machine itself presents a less complicated problem for thorough inspection than it does when the old system of fitting is employed. Thoroughly-organized tool rooms follow as a necessity. Every operation must be specialized, and by constant study and experience in one class of work the cost of production is reduced to a minimum.

The moral effect which automatic fast-running machinery has is a factor which neither workmen or employers can despise ; but the whole establishment must be brought into harmony with this class of machinery, or its introduction will not be productive of the best results. Labor-saving machinery, as a rule, calls for the best workmanship in its construction. The standard of excellence will, by association, be gradually raised, and, if good management prevails, all will in time adapt their pace to that of the highly-productive machine. Where labor-saving machinery is introduced, it naturally follows that labor-saving machinery will be produced, and commercial advantages quickly follow, for it is a well-known fact that trade and commerce naturally drift towards those centers where the united efforts of a community result in producing the best article. In spite of protective tariffs, political humbug, and national conceit, industrial and commercial supremacy will assert itself, and, with the aid of the steamship, cable, and postal facilities, will penetrate to the most remote corners of the earth. Whenever it is possible for any one country to produce the highest grade of work, the greater part of the demand of the civilized world for that class of goods will seek supply in that country.

It is well to attempt to answer the question: what constitutes the most effective plant for the production of machine tools? It is that plant which produces the greater part of its work by unskilled workers operating labor-saving machinery kept in order and supervised by the skilled labor of the higher wage-earner. On the contrary, an uneconomical, low-wage-earning factory is one which is equipped with ordinary machines, operated by so-called skilled labor receiving a uniform rate of wages, where the net results are a product which is expensive and neither uniform or of the highest grade. Of the former type is the usual American machine shop; of the latter the average European machine shop. The average wages paid in the American factory are higher than those in the European, and are, in special cases, in excess of anything ever received by the European "engineer." However, the value of the product of the American shop exceeds, proportionally, that of the European by more than the excess in wages. It must be remembered that, to be valuable, a high-priced workman need not necessarily turn out a great quantity of work, and that a low priced workman may be a very expensive producer, even when turning out large quantities. I have seen in European factories lads attending hand milling machines who forced the parts underneath the cutters at three times the rate of feed that should have been employed, and produced work to which the fitter must have given three times the amount of labor to bring it to a finished state that would have been required if this same work had been put through automatic machines. In the above case a slow automatic feed could be used, and one lad could attend three machines which could be kept in a high state of efficiency by a well-paid toolmaker. The work would leave the machine in a very nearly finished state, and very little hand work would be necessary. The employer's capital would be invested in labor-saving machinery and high-wage tool-makers, which would yield him greater returns than hand machines and lads at two shillings per day.

The two main factors which enter into the cost of a machine are, of course, wages and material. Some consideration of the materials used by the American manufacturers, as compared with those used by Europeans, will be of interest, for this reason,—that the cost of production is largely dependent on the ease with which material can be worked. Again, automatic labor-saving machinery cannot often be successfully worked unless the highest grades of material are used. It is admitted, by those who have had the opportunity of observing, that it is apparently impossible for the European foundry to turn out a quality of cast iron equal to that generally used in the construction of American machine tools. The price of cast iron for machine tools in America is about the same as in Europe, but the quality is very much superior for machine-tool purposes, and the American pays great attention to securing a quality of cast iron that can be easily machined. In special lines, like that of harvesting machinery, castings are produced for one cent per pound. For most American machines a soft, close-grained iron is used, which is easily worked, and is not very destructive to cutting tools; at the same time, it has good wearing qualities and easily takes a high finish. With such cast iron it is possible to take faster cuts on the planing machines than is usual in European practice, and it also permits extensive and economic use of the milling machine. A prominent English steel maker has informed me that tool steel supplied to America is generally of a lower carbon than that furnished to European manufacturers. This is due to the fact that American iron is uniformly of a softer grade than European. This is certainly an advantage to the American. It is also to his advantage that he is able to purchase at a low price the soft machinery steel so largely used in the construction of machine tools. I know no German or English makers who can supply a good quality of soft steel to compete with that delivered at works in America for one and a half cents per pound. This steel is of soft quality and very uniform, and answers every requirement for a great many parts of a machine tool. It can be rapidly cut, and it takes a high finish. It also runs more accurately to sizes than the European product. This one fact is highly essential for the successful working of certain classes of automatic machinery. In America sheet metals are more accurately rolled and finished, and are lower in price, than they are in Europe. The interesting question as to the comparative merits and prices of materials is too extensive to be dealt with at this time. However, it is pertinent to state that the use and value of special high grades of material, which enter into the construction of, and are important adjuncts to, the economic working of machine tools, are not yet fully comprehended by European manufacturers, and consequently are not demanded by them. As long as this state of affairs continues, it cannot be expected that European manufacturers of material will exert themselves to compete with American in supplying these high grades at low prices. The first essential—demand—is wanting. It is interesting to note that American manufacturers have not a reputation for supplying the uniform quality of tool steel produced by the best English makers. Many of the best makers of machinery in America purchase their tool steel from England.

A careful study of the situation on the part of European makers of machinery will surely result in the adoption of much of the American practice. The extensive introduction of labor-saving machinery in America is developing a highly-paid, valuable, and efficient type of workman. European employers who, more or less, recognize the advance of labor-saving machinery must, at the same time, realize that they cannot keep to the front if they do not try to secure a class of workers necessary to maintain labor-saving machinery at its highest degree of productivity, by paying wages which intelligent and skilful men must have. Workers who do not recognize the labor-saving machine, not only as the producer of a better and cheaper article, but also as a means of elevating their craft and making higher wages possible, must suffer in competition with other nationalities.

THE AMERICAN ISTHMUS AND THE INTER-OCEANIC CANAL.

By W. Henry Hunter.

THE case for the severance of the isthmus which unites the northern and southern American continents, and thus divides the Atlantic and Pacific oceans, is presented by a glance at a map of the western hemisphere, and, to the mind of one capable of discerning the trend of events in the days in which we live, is established by a study of the same map.

The Atlantic and Pacific form the two great highways of the planet. To them all others are subsidiary,—adjuncts, or in the relationship of attenuated extensions,—whatever their character, their dimensions, or their position. At the Central American isthmus these two great through routes, upon which the commerce of the world and the progress of the nations depend, are divided by a neck of land, which, at any rate on one of the proposed lines of severance, is but some forty miles in width—but five miles longer than the channel excavated by local enterprise for the Manchester ship canal.

If it were necessary to emphasize by any particular claim of special advantage, the general benefit to commerce which would most certainly follow the opening of the inter-oceanic canal, we would base that particular claim, not upon the shortening of the distances between the eastern and western sea-boards of the United States, or upon the political gain to accrue from the reduction of distance between the naval outfitting ports on the northern Atlantic and the Philippine islands,—though these results would be important,—but on the effect which would be produced upon the tropical districts of the west by the construction and working of the canal.

The accomplished author of "Social Evolution" has recently issued a short, but weighty, *brochure*,* in which he has dealt with the general question of the tropical regions,—with their enormous capacities of production, on the one hand, and with the present wretchedness of their condition, on the other hand. He justly describes that condition as "altogether deplorable." He says: "A blight seems to hang over the whole region. There are only two words which adequately represent the condition of the immense territories included—anarchy and bankruptcy"; and he suggests the removal of the blight by the substitution, for the anarchy, of strong and righteous government,—that is to say, government by the governing races of mankind, by the great civilising powers of the world.

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* *The Control of the Tropics.* By Benjamin Kidd. New York. The Macmillan Co.

Anything which will conduce to this will confer a benefit on mankind for which no adequate standard of measurement can be found. It will, in truth, do something to hasten the fulfilment of the poet's vision, when

> Through Orient seas, o'er Afric's plain,
> And Asian mountains borne,
> The vigour of the northern brain
> Shall nerve the world outworn.

No one can doubt that the construction of an international highway through the Central American isthmus will tend to improve administration in the American tropics, to the nerving of that "world outworn" by "the vigour of the northern brain"; for this reason, then, if for no other, the isthmus *must* be severed, and the international highway made.

There are other reasons for the construction of this great junction of the seas,—reasons so many and so weighty that they have impressed men of perspicacity and enterprise for generations past, from Hernando Cortés to Ferdinand de Lesseps; men who were in advance of their time, men who saw clearly when other men were blind, men who agreed as to the necessity for the junction, but who differed as to the manner in which it should be effected.

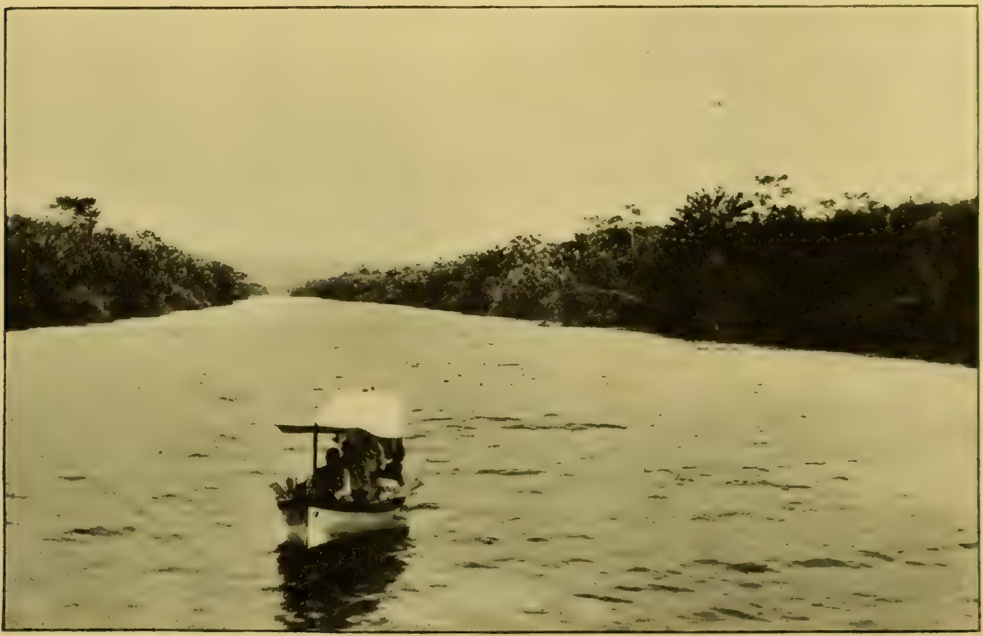
Out of their differences arose the different schemes propounded from time to time: for a canal on the Darien line; for a canal on the Panama line; for a waterway (formed of junction canals at either extremity and of an existing inland sea) on the Nicaragua line; for a ship railway on the Tehuantepec line, which was the project of the late Captain Eads; and others of lesser importance.

Of these schemes but two survive,—the Panama canal and the Nicaragua waterway,—and their respective promoters and supporters struggle for the mastery.

As is usual in such case, all manner of side issues are being raised in the struggle; herrings are being trailed across the track, and considerations, some of them very unworthy, having no real bearing upon the point at issue (which ought to be simply the determination of the best and most appropriate method of achieving the desired purpose), are being dragged into the discussion by heated advocates and by indiscreet partisans.

Against this the minds and instincts of men of science must revolt. A scientific question of vast importance to humanity cannot be settled by appeals to international jealousies and racial hatreds. These are, alas ! all too easily aroused. Political equilibrium is proverbially unstable, and mutterings about "control," once set going, soon serve their purpose of disturbing that unstable equilibrium. Then prejudice takes the place of argument, and rhetorical invective does duty instead of facts and figures.

We desire to avoid, in these pages, all extraneous questions, and to present, with such brevity as the circumstances will admit of, the salient features of the two rival routes, hoping that in this way we may be able to contribute to such a solution of the problem as will commend itself, by its loyalty to sound engineering and economic principles, to the minds of all competent and impartial judges.



THE FINISHED PORTION OF THE PANAMA CANAL, 10 MILES FROM COLON.
It is completely excavated to this width for 24 kilometers—14.9 miles.

I.—THE PANAMA ROUTE.

It is to the credit of M. de Lesseps that he advanced further than any of his predecessors in title in promotion of the Panama canal, in that he made a determined effort to achieve that which they had but desired.

The effort ended in disaster ; disaster which is now a matter of common notoriety, and of which the story has been told often and in terms so fittingly unsparing that the public mind has come to regard it as irretrievable, and, in some measure, to look with prejudiced eye upon any attempt to convert the disastrous failure into a meritorious success.

In 1888 M. de Lesseps's company collapsed. What is now known as *l'ancien compagnie* stopped payment, and, in accordance with the requirements of the French law, a searching and extended examination of its affairs and its administration was made by duly-qualified legal officials.

The result was twofold. In the first place, there was a scandalous exposure of malfeasance, the like of which has not been seen since the days of the South Sea Bubble, followed by criminal proceedings in courts of competent jurisdiction. In the second place, the skilled and impartial officials to whom the examination was committed became possessed of two decided convictions: (1) that the Panama canal could be made and should be made; (2) that *l'ancien compagnie* had really done more towards the achievement of the waterway than it had at first been given credit for, and that the work which it had executed could be advantageously utilised in a renewed effort to effect the completion of the canal.

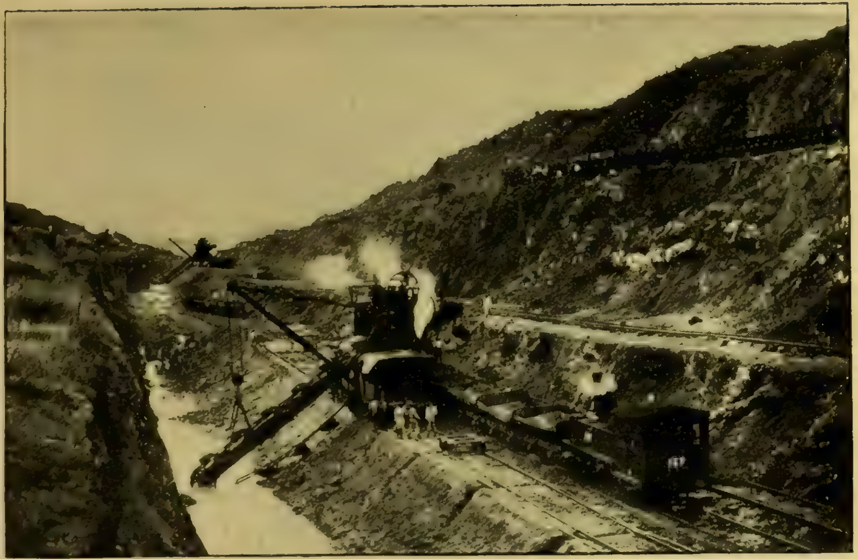
Impelled by these convictions, *les mandataires de justice* themselves took action, after several abortive attempts at reconstruction had shown the helplessness of the representatives of the old company.

To appreciate the difficulties with which the liquidators were confronted at the time at which they intervened,—say, at the end of 1893,—it is necessary to recall one particular of their entangled environment.

The government of the republic of Colombia had granted to the old company a most valuable concession, by which that company was not only authorised to make the canal, but placed in possession of some 15,000 hectares of land upon the route of the canal, on which the company had erected workshops, stores, hospitals, administrative buildings, etc., at a prodigious cost; and upon which it had also collected masses of plants and materials.

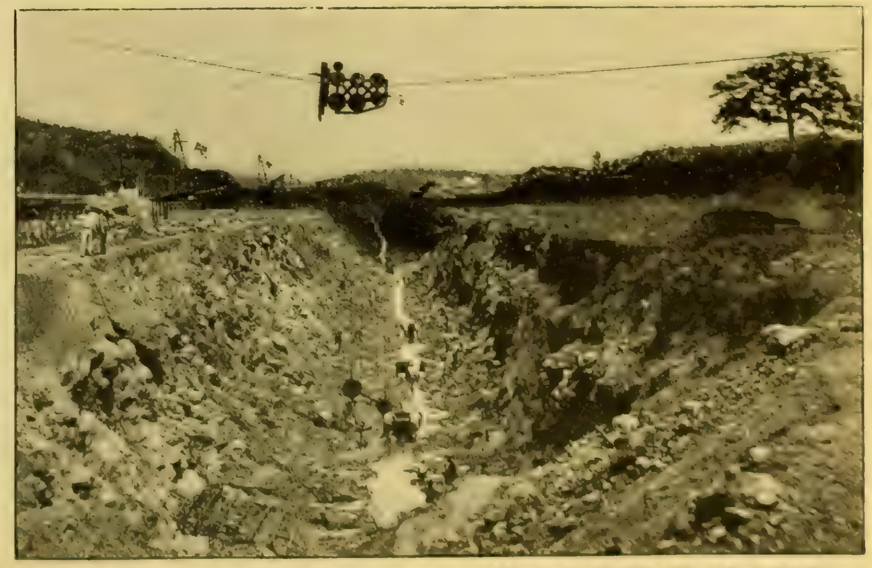
It was necessary, if this great concession was to be preserved, that, on or before October 31, 1894, the works should be re-started "*d'une manière serieuse*"; there was to be no humbug about it.

There was, therefore, but little time for carrying through the intricate arrangements which had to be made; but the liquidators faced the situation with stout hearts and hopeful spirits. They entered into negotiations with some of the great financial houses in France, and secured their powerful support. They also made representations of an effective character to certain of the persons who had profited by transactions with the old company, and informed those persons that, in the judgment of the liquidators, it was desirable, in their own interest, that they should subscribe the funds required for the re-opening of the works in the isthmus. Further, they obtained special powers from the French legislature, and finally they established upon a firm and substantial basis "La Compagnie Nouvelle du



EXCAVATORS AT WORK IN A CUT.

THE PARTIALLY-COMPLETED CANAL AND THE PANAMA RAILROAD.



THE CANAL AT EMPERADOR. AMERICAN CABLEWAYS AT WORK.

THE CANAL 32 MILES FROM THE ATLANTIC, LOOKING TOWARD COLON.

Canal de Panama," with a capital of 65,000,000 francs, or about £2,600,000.

The new company was definitely formed on October 20, 1894, just eleven days before the date on which the concession would have lapsed. The margin was very small, but it was enough; for vigorous measures were taken, the concession was saved, and the directors of the new company set about the discharge of the duties which they had undertaken. These were: (1) to preserve the concession; (2) to prove experimentally whether the construction of the canal was feasible; (3) if shown to be feasible, to prepare a project for construction, which would command the confidence of impartial men in the engineering, financial, and commercial world.

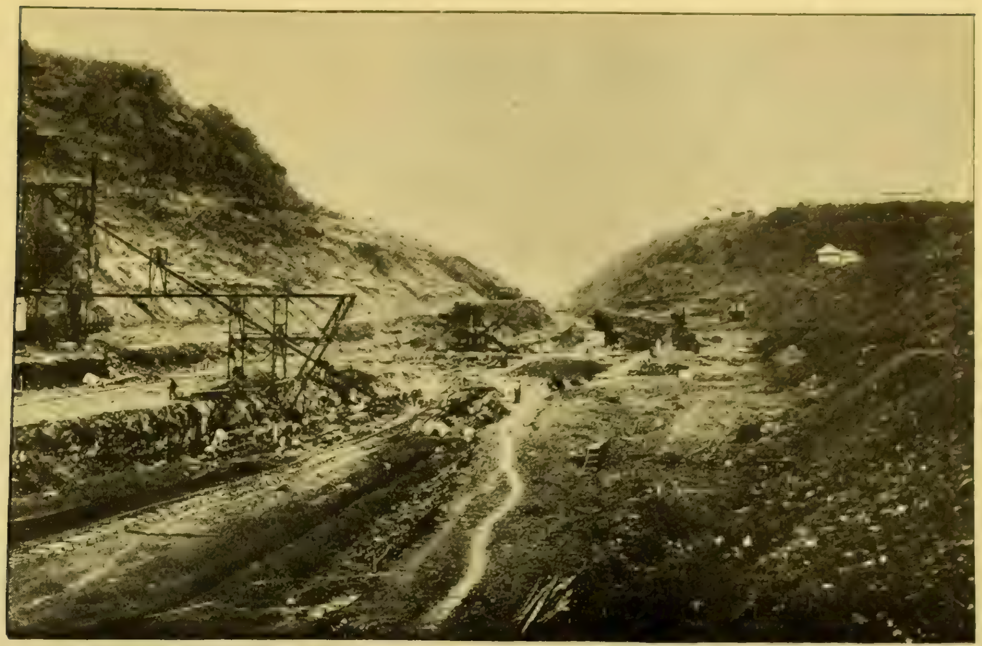
Some indication of the manner in which the duties have been discharged is afforded by the following particulars:

(1) In 1895, the company employed 3,000 men, and 370,000 cubic metres of material were removed; in 1896, the figures rose to 4,000 men and 700,000 cubic metres; and, in 1897, to 3,600 men and 960,000 cubic metres. Thus the terms upon which the concession was originally granted have been complied with, and work of substantial and permanent value has been carried out. Some idea of its extent may be gathered from the accompanying engravings, made from photographs taken on the spot.

(2) It was felt that three special difficulties, inherent and peculiar, confronted any would-be constructors of the Panama canal.

(*a*) The regulation of the river Chagres, a capricious tropical

SITE OF THE BOHIO LOCK. CUT OF 160.7 FEET.



THE CULEBRA CUT. THE GROUND ORIGINALLY EXTENDED FROM ABOVE THE CREST ON THE LEFT TO THE HOUSE ON THE RIGHT-HAND BANK.

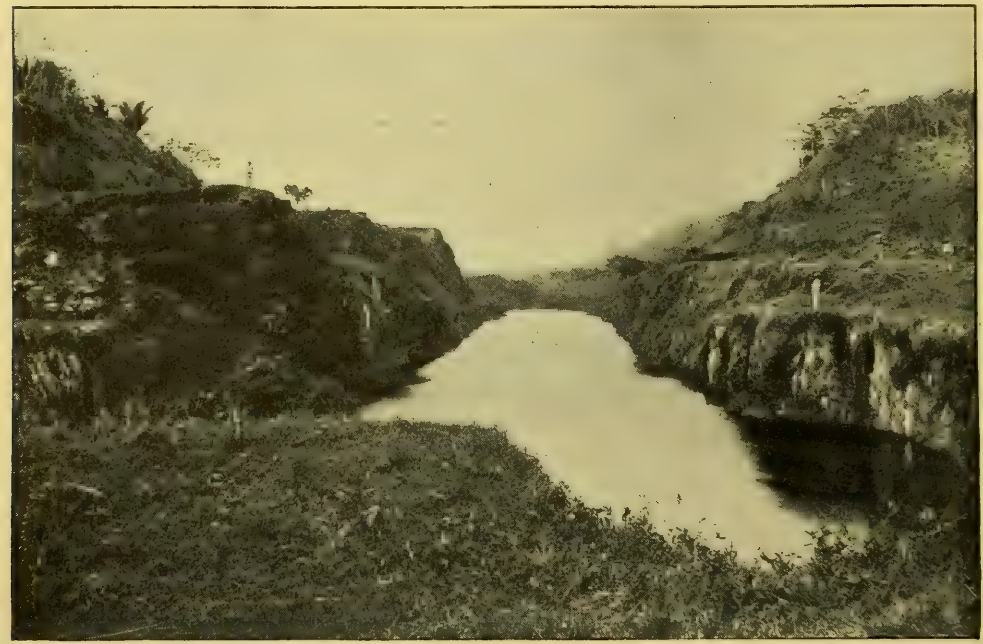
stream, flowing from east to west, discharging into the Caribbean sea to the westward of Colon ; now winding its way in gentle stillness to the ocean, anon breaking out into torrential turbulence and foaming down its valleys in fierce floods for days together. This unbridled water course formerly cut the line of the canal at a dozen different points, presenting an obstruction at each. To avoid these obstructions extensive river diversions have been formed, through which the river now flows, and which have proved effective at all times except those of heavy floods. To provide for these much more extensive works will be required.

(*b*) The cutting through the Cordilleras, which, on the line ot the canal, form the "divide" between the watersheds of the Atlantic and the Pacific.

Great uncertainty existed as to the character of the material to be excavated, particularly in the two heights, which stand in proximity to each other, to the southward of the centre of the isthmus ; the more northerly height being known as Emperador, and the southerly (and greater of the two) as Culebra. To determine the real nature of the material, the directors decided to drive a "*cunette preparatoire*" through the peaks Emperador and Culebra.

In modern surgery, when uncertainty is felt as to the diagnosis of some internal trouble in a patient, the surgeon is as likely as not to proceed to make what he euphemistically describes as an "exploratory incision," which means that he cuts into the living man, in order to ascertain with precision what the nature of the sufferer's malady is.

The *cunette preparatoire* was an "exploratory incision" made in clay and schist and rock instead of in the living fibres of a human body; and the result of its execution (taken in conjunction with the results of numerous borings which were made and of trial bits which were sunk) was to demonstrate in an unquestionable way, that the strata through which the canal cuttings will pass are of such a nature as to relieve the promoters from all fear of disastrous slips or land-slides, either during or after construction.



THE CANAL AT SAN PABLO, 23 MILES FROM THE ATLANTIC.

(*c*) The climatic conditions under which the work must be undertaken, and the lack of efficient sanitation.

It is commonly reported that, in the course of the construction of the Panama railroad, which was carried out by an American company, and of which the route is nearly identical with that of the proposed canal, the laying of a sleeper or tie and the burying of a Chinaman were operations which were conducted concurrently by the constructing company. There is much of picturesque exaggeration about the statement, but undoubtedly the mortality was very heavy in those days, as it was also in the days of the old canal company.

The past, therefore, has been unfortunate; it is also irretrievable. But, learning from past failures, the new company proceeded on lines different from those followed by its predecessors. Drainage works were undertaken; sanitary regulations were enforced; the health of the employees was watched over; efforts were made to confine the immigration of workers to persons whose constitution and habits of life fitted them for residence and labour in the tropics.

The effect of all this, taken in conjunction with the works executed, has been an almost sensational degree of success. The route has been opened throughout its entire extent by means of the partially-completed cuttings; the trees and jungle-like undergrowth have been cleared from the line; thus an air channel has been formed, in which deadly stagnation has been replaced by revivifying currents, which pass as fresh breezes from sea to sea.

It has been proved by trial that coloured labourers can work all the year round in the isthmus; that, of the number employed, at least 97 per cent. may be expected to be at work in perfect health at one time; that yellow fever and the other dread ailments of tropical swamps are not indigenous to Panama; and that, with ordinary care, Europeans may live there for years together without experiencing, by the fact of such residence, any serious increase of the peril of death in which all men always stand.

CANAL EXCAVATION AT LA COROSITA, 28 MILES FROM THE ATLANTIC.

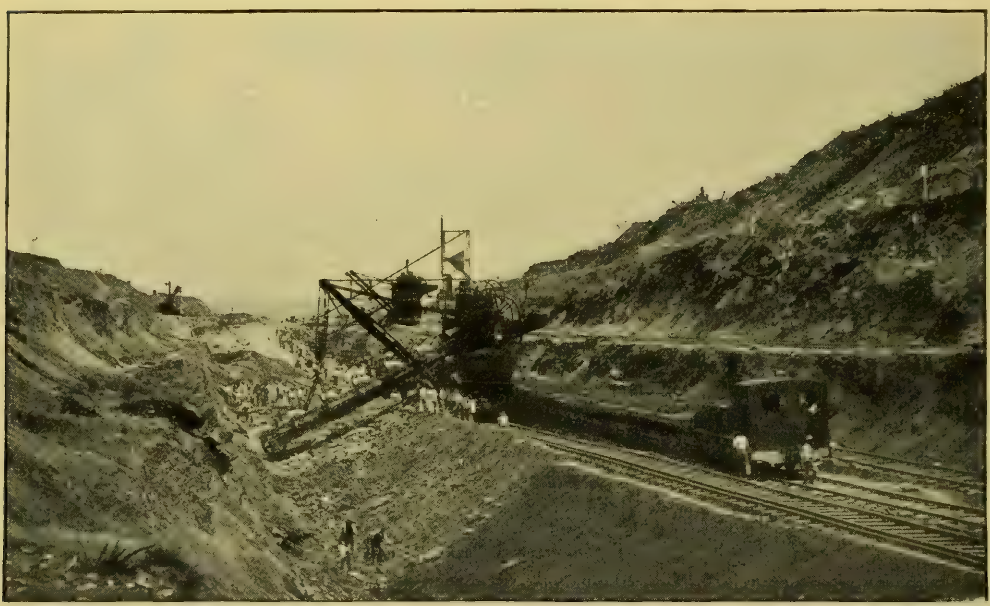
The directors of the new company may, therefore, justly claim that they have fulfilled the following functions: (1) preserving the concession; (2) demonstrating the practicability of the construction of the canal; (3) coping with the climatic conditions of the isthmus.

But a further duty devolved upon them,—*viz.*, that of preparing a project for the completion of the canal as a permanent work and as a navigable waterway,—a project which would, despite the previous failures of the old company, command the confidence and enlist the sympathies of competent men of all nationalities.

In the discharge of this duty they obtained the best engineering advice available, and formed a competent engineering staff. In addition to this, acting under special legislative enactment, they summoned to their aid a number of outside engineering experts,—French, German, Russian, American, and English: all of them men holding, or having held, responsible positions, impartial in judgment, and possessed of such experience as to render each man specially fitted to advise on the proposed design and method of construction.

In this way the *Comité Technique* was formed.

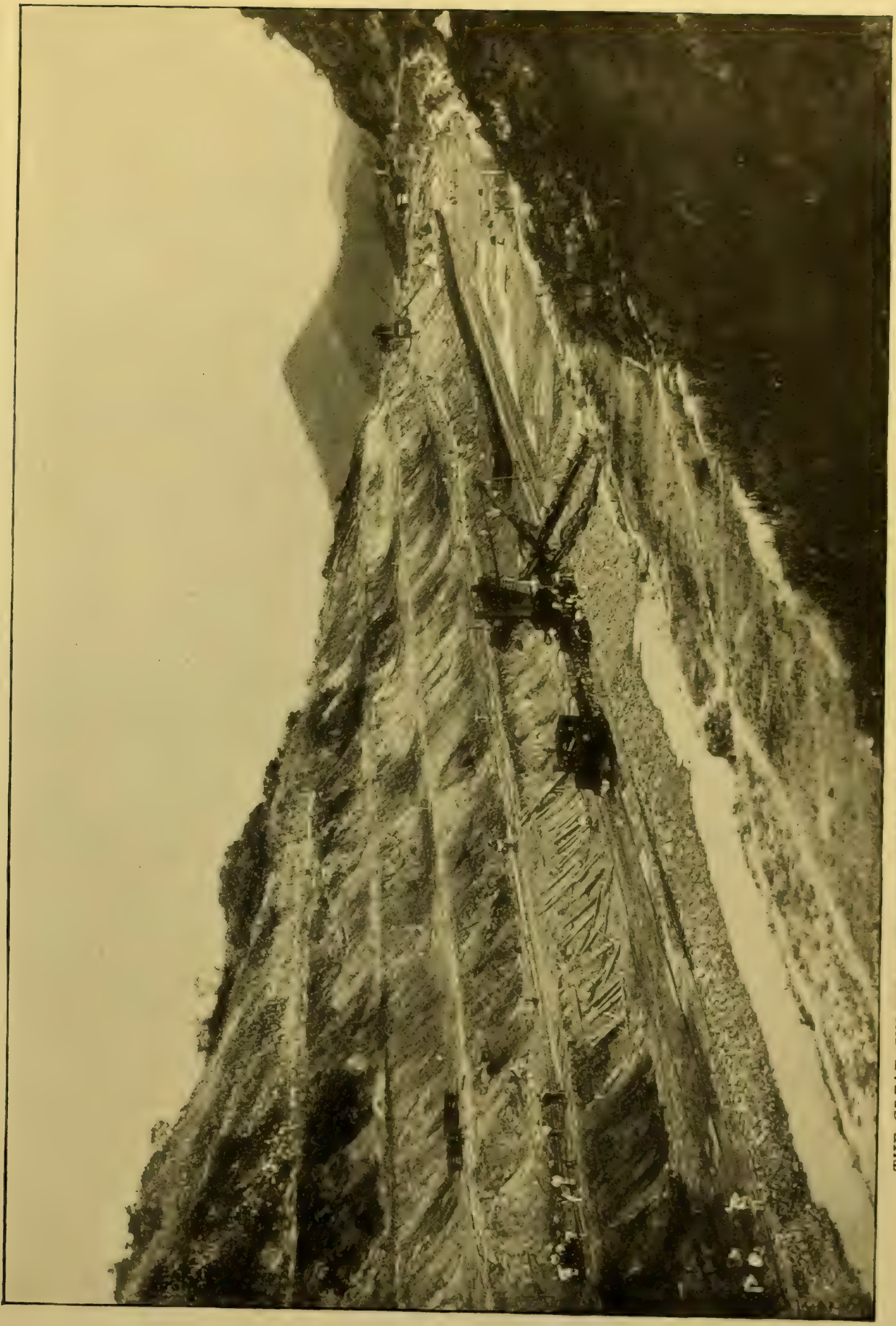
The *Comité Technique* was no merely ornamental appanage; the position of its members was by no means of an honorary sort. In conjunction with the directors and the leading officers of the company, it held nearly one hundred protracted sittings between the beginning of 1896 and the end of 1898, at which the whole of the main lines of the project were considered in closest detail.



THE CANAL 33 MILES FROM THE ATLANTIC. FRENCH EXCAVATORS LOADING CARS.

As an example of the conscientious and painstaking way in which the members of this joint board discharged their duties, it may be noted that no less than sixteen different proposals for the arrangement of the longitudinal section of the canal were discussed by the board, and the pros and cons of each weighed, before a final decision was arrived at, troublesome and laborious though the process was.

Thoroughness characterised the whole of the proceedings of the board; nothing was left to chance; everything was, as far as possible,

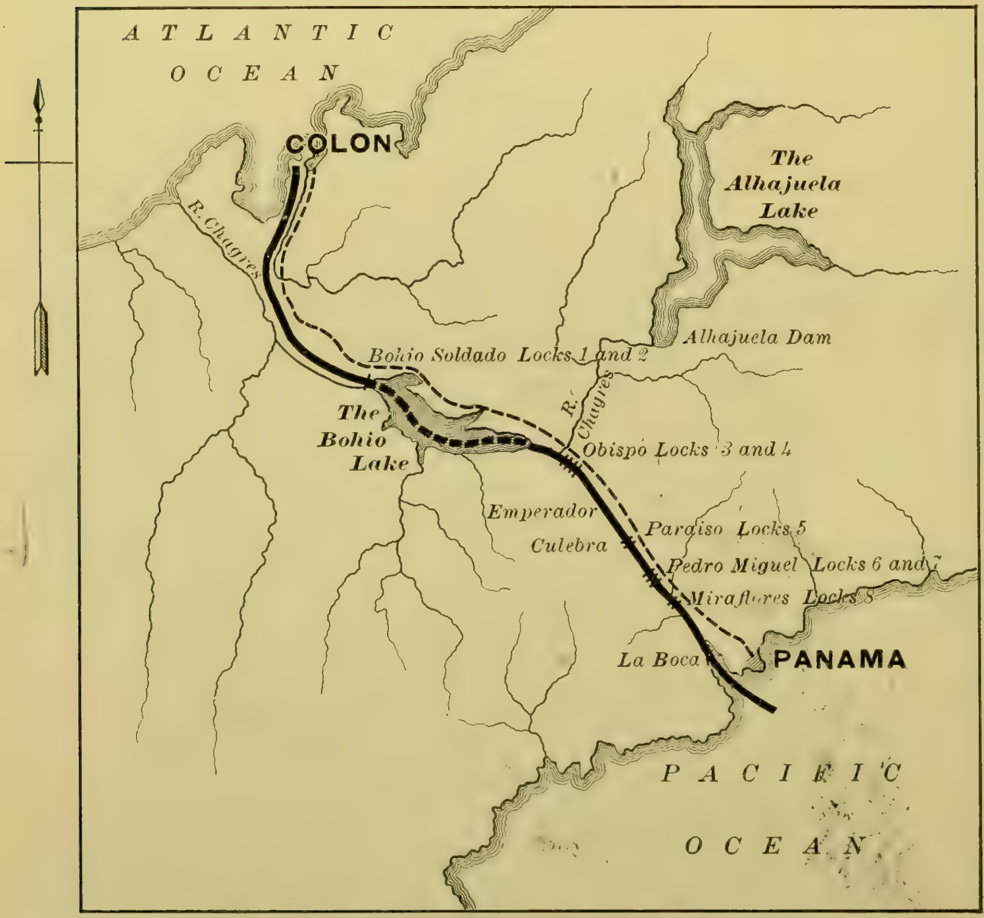


THE GREAT CULEBRA CUT, 34 MILES FROM THE ATLANTIC, SEPTEMBER, 1897. LOOKING SOUTHWARD.

ascertained. Under the direction of the *Comité Technique* the whole of the route of the canal and of its collateral works was accurately surveyed and contoured; borings were made, trial pits sunk, streams large and small, (including the wayward Chagres) gauged, meteorological observations made and recorded, and generally a mass of facts accumulated through which the *Comité* was enabled to agree upon a project for the completion of the Panama canal, with which the new company is prepared to face—indeed, to invite—the criticism of the world.

The project, thus elaborated, is indicated on the plan (Fig. 1) and longitudinal section (Fig. 2) shewn on this page and the page opposite. The necessarily minute scales of the plan and section forbid the introduction of any detail; it is hoped, however, that the following brief descriptions will make the little drawings clear to non-technical as well as technical readers.

The termini of the canal are Colon on the Atlantic coast, and



NOTE. Line of Panama Canal shown thus ▬

FIG. I. PLAN OF THE PANAMA CANAL.

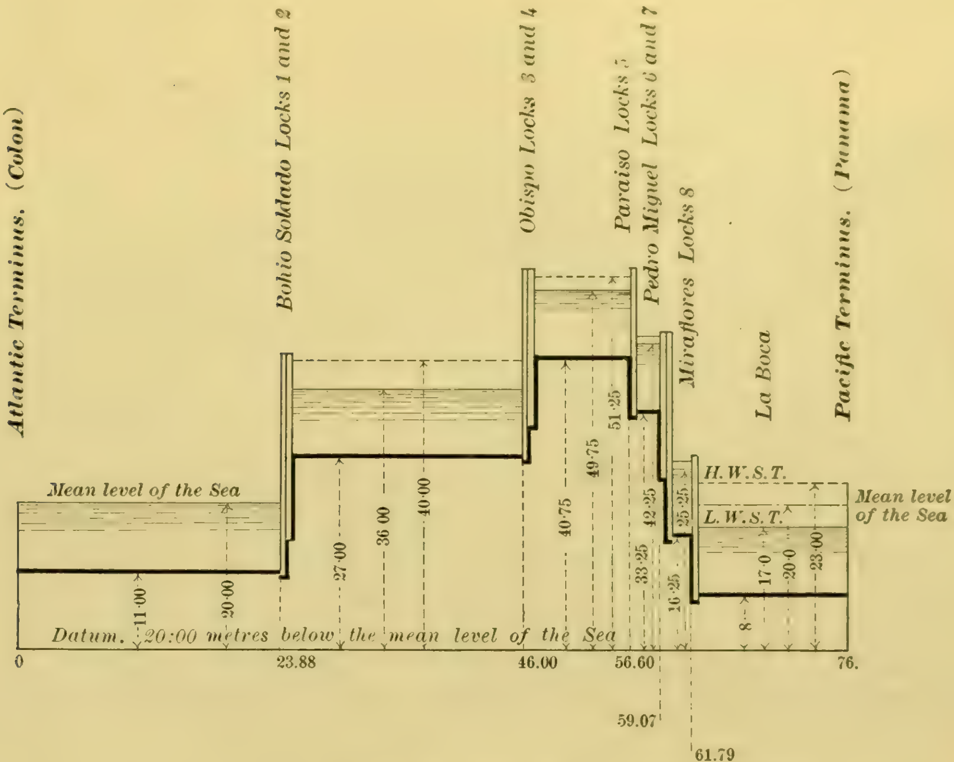


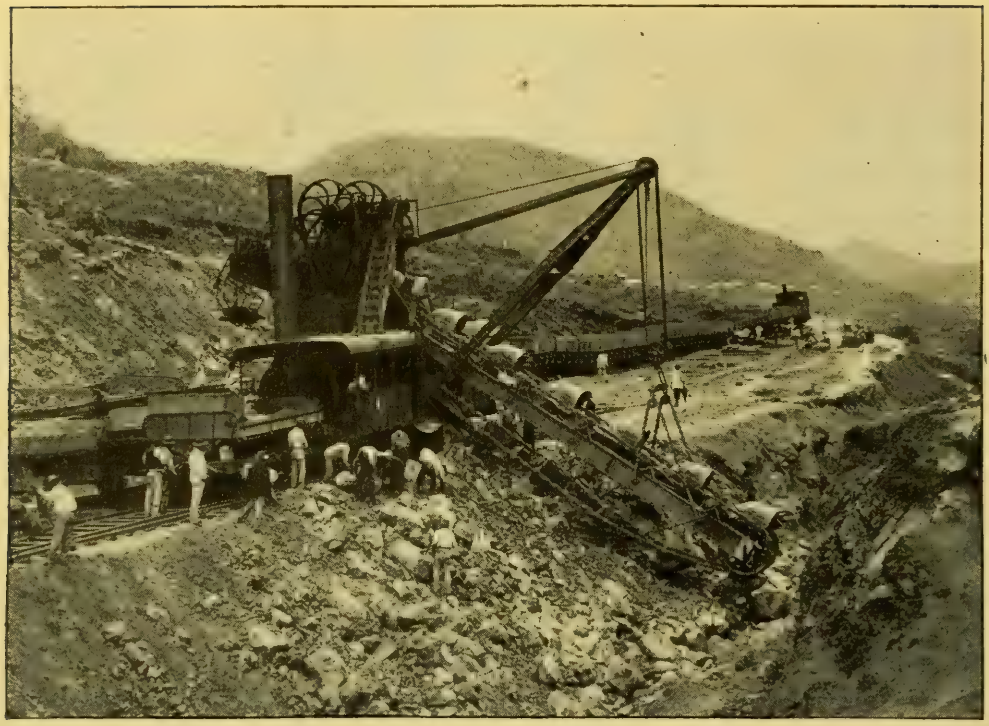
FIG. 2. LONGITUDINAL SECTION OF THE PANAMA CANAL.

This section shows the "Mean-Level Dividing-Lock System"; two other plans were considered by the *Comité Technique*—the High-Level, with the bottom of the summit level 29.75 metres above sea, and the Low-Level, with the bottom of the summit level only 9.75 metres above sea. The canal, on the present line, can be brought down to sea level whenever the conditions warrant the expense.

Panama on the Pacific. A line joining these two points would run, approximately, north-west and south-east. The distance between them is 42 miles, measured as the crow flies, and 46½ miles, measured on the line of the canal.

The canal is to be divided into six reaches; a maritime channel is to be formed on either sea-coast, and these channels are to be connected by four intermediate ponds of varying lengths.

The channel on the Atlantic coast covers nearly one-third of the length of the canal, being itself 24.20 kilometres in length. The bottom width of the channel will be 30 metres, and the depth below the mean level of the sea (which is here practically tideless) will be 9 metres. The Atlantic channel (which is already completed, requiring but comparatively small quantities of dredging to give the full width and depth) will terminate on the flank of a hill at Bohio Soldado, where the first group of locks will be formed. The Chagres passes near to the site, the valley in which the river-bed lies being comparatively narrow at the place, confined as it is by high ground on either side. Advantage has been taken of this natural formation, in the design of the canal works.



EXCAVATOR AT WORK AT THE EXTREME WESTERN END OF THE CULEBRA CUT.

It is intended that the valley of the Chagres shall be closed by a great embankment of earthworks, so constructed as to form a water-tight dam. By this means a vast lake will be formed behind the Bohio locks, the effect of which in the regulation of floods will be considered later. As an adjunct to the dam, a channel for the discharge of flood waters, which will be controlled by sluices of the Stoney type, will be constructed at Bohio.

The second reach of the canal will extend from Bohio to Obispo (a length of little more than 22 kilometres), and will, for the most part, be formed through the great Bohio lake, the width at the bottom being 50 metres, and the height above the mean level of the sea 7 metres. At Obispo a second group of locks is to be constructed, and at this point the summit-level of the canal will be attained, the reach from Obispo to Paraiso, where a single group of locks is to be built, forming the "divide" of the canal, or, as the French say, *le bief de partage*. The length of the dividing reach will be 10.65 kilos, the bottom width 36 metres, and the height 20.75 metres above the mean level of the sea.

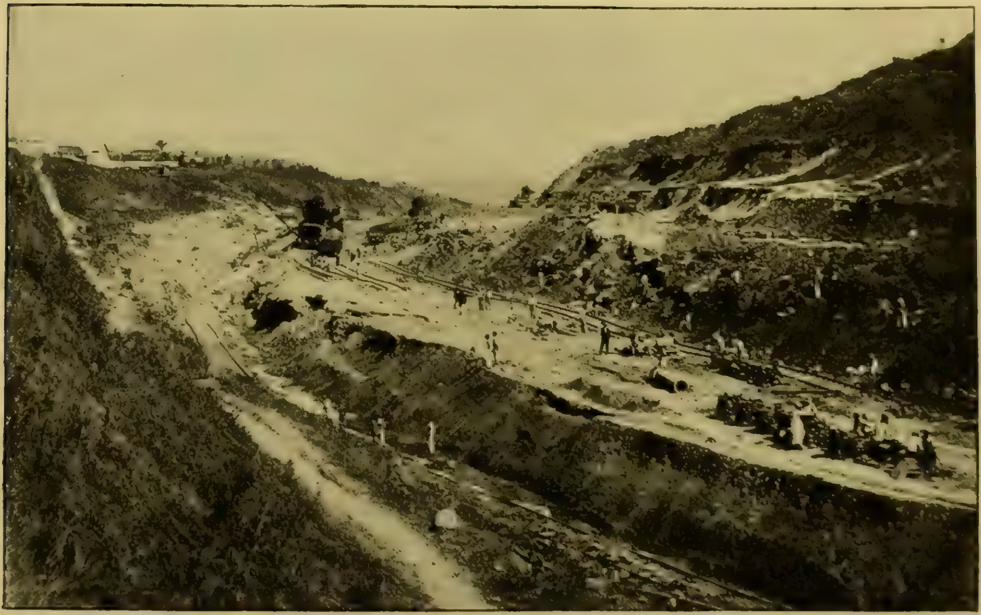
Then will follow two short ponds from Paraiso to Pedromiguel, and from Pedromiguel to Miraflorés. A double group of locks will be built at Pedromiguel, and a single group at Miraflorés, the respective lengths between the locks being 2.50 and 2.70 and the respective levels at the bottom of the ponds being 13.25 metres above, and 3.75 metres below, the mean level of the sea, the width at bottom being 30 metres in each case.

At Miraflorés the level of the Pacific will be reached. The Pacific channel will be 12.70 kilos in length, divided into two parts, of which the first will extend from Miraflorés to the port of la Boca, and the second from la Boca to the terminus in the ocean. The width of the first part at the bottom will be 30 metres, and of the second 50 metres, the level of the bottom being 12 metres below the mean level of the sea, a tidal range of about 6 metres being experienced in the gulf of Panama at spring tides.

It will be noted that, in the foregoing description, the levels given, have, in all cases, been of the bottoms of the intended channels and ponds. A minimum depth of water of 9 metres will be maintained throughout, but provision will be made which will permit of a considerable increase of the depths in the various ponds during times of flood, while at high water of spring tides the depth in the Pacific channel will be increased to 15 metres.

In the design of the canal, of which the leading features have been thus indicated, the answer to the crucial questions (1) as to the alimentation of the "divide" and (2) as to the regulation of the floods of the Chagres have been answered in a proposal as bold as it is free from complexity, and, so far as can be foreseen, as certain to be effectual as any engineering effort to control the forces of nature can well be.

The detailed surveys of the upper valleys of the Chagres brought

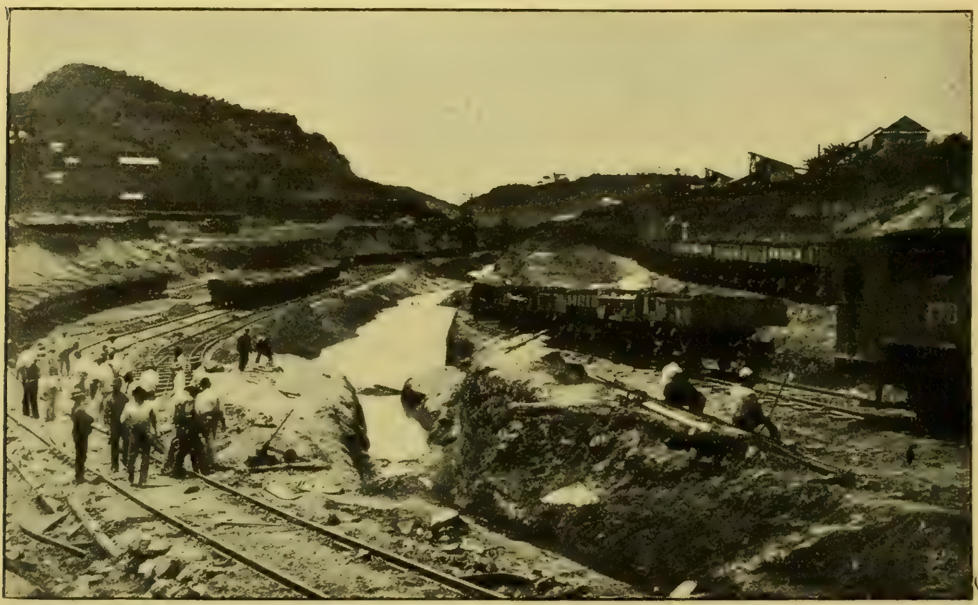


THE WESTERN END OF THE CULEBRA CUT.

into prominence the fact that, at a place bearing the uncouth appellation of Alhajuela, and lying about 16 kilos to the north-eastward of the lines of the canal, the river flows through a rocky gorge which forms a constriction of such sort as almost to lead one to regard it as a special provision of nature for the assistance of her sons in their effort to control some of her more turbulent forces.

In this rocky gorge, on the rock of which it is formed, and of the rock by which it is surrounded, it is proposed to construct a great dam, after the style and character of that built by Mr. Fteley as a part of his magnificent works for the water-supply of New York.

The proposed dam will be about 286 metres in length, measured along its crest, and about 50 metres in height, measured from foundation to summit at the deepest part of the valley.



OUTLET OF THE CULEBRA CUT ON THE PACIFIC SLOPE.

Behind this dam a second great lake will be formed, in which the minimum level of the water will be 58 metres and the maximum level 67 metres, thus furnishing a vast capacity for the storage of flood waters, which can in this way be impounded and employed as required for the feeding of the canal.

Between the dam and the line of the canal a *rigole d'alimentation*, or feed-water conduit, will be formed along the flank of the high ground on the left bank of the river; this conduit will be similar in many respects to the "flumes" of California, and will serve the same purpose as they do, and in the same manner, but on a larger scale.

It is unnecessary to cumber this review with descriptive particulars of the manner in which it is proposed that the different works shall be executed, and of the progressive steps to be taken and stages to be reached, season after season, year after year. All this has been elaborated thoroughly and in patient detail, but need not be dwelt upon here. Neither is it necessary that we should attempt to epitomise the volumes of calculations which have been made of the flow of the Chagres, whether in respect to the whispering trickle of its stream in times of extreme drought, or the roar of its turbulent torrent in times of greatest flood. Figures without explanation are misleading, and, even with explanation, form but dry and uninteresting reading, except to statisticians—a limited class; and we confess to a desire to make this review serviceable to the largest possible number of readers, seeing that the matter of which we treat is one of profound importance for humanity at large, and of importance not only for the present day and for the present generation, but for days yet in the future and for generations yet unborn.

By the aid of the regulating works already described, it will be possible to work the canal in perfect safety at all times, and to hold even the greatest floods under perfect control.

Ordinary freshets and floods of small degree will be stored in the Alhajuela lake alone, whence their waters will be allowed to flow through the conduit, and in such quantities as the traffic may require, to the "divide" of the canal. Careful calculations have shown that a sufficient quantity of water can be impounded in the lake and between the planes of maximum and minimum water to feed the canal for more than twelve months, even if a single drop of rain did not fall within the limits of that period. It may be safely said that no such drought has taken place in Central America since men appeared on this planet, nor will take place until the day comes when the planet's "elements shall melt with fervent heat."

The construction of the Alhajuela dam will therefore provide for the alimentation of the canal at all times, and for the regulation of ordinary floods.

For the great and exceptional floods the storage capacity of the Alhajuela lake will be supplemented by that of the lake at Bohio. Provision has been made for raising the level of the Bohio lake by 4 metres. Special arrangements have been devised whereby the surplus water from Alhajuela may pass down the old course of the Chagres, through the dividing reach, and thus flow into the Bohio lake, whence they will be allowed to pass on their way to the ocean through the various river diversions in such volumes and over such times as the engineers in charge of the working of the canal may determine.

Given accurate data to work upon, the results arrived at by hydraulic calculation are absolutely certain and reliable. Such calculation shows * that a steamer will be able to pass from end to end of the Panama canal at the height of the tropical rainy season and at a time when the Chagres, if left to its own devices, would have been boiling down in tempestuous flood, without finding a current at any point, either with or against her course, of more than two miles per hour.

The promoters of the Panama canal therefore claim, and, it must be admitted, with some reason, that in their project the bogie of the Chagres floods has been effectually laid.

But little is required to complete this brief description of the outlines of their project. The route has been judiciously selected, and the line carefully laid out. More than half the total length is absolutely straight on the plan, and for the remaining portion the curves are so easy as to be practically negligible from the point of view of navigation. It will have been noted from the description already given, and will be seen in Fig. 2, that there will be eight sets of locks in all, four on either watershed. The locks will in every case be constructed in pairs, a larger lock and a smaller lock lying side by side. The dimensions of the larger lock will be 225 metres (working length) by 25 metres, with central depth of 10 metres ; of the smaller locks, 225 metres by 18 metres by 10 metres. It is proposed to equip the smaller locks with intermediate gates. Approach basins will be formed above and below the locks, and the mid-feather, or pier, separating the adjoining lock chambers will in each case be prolonged into these basins, so as to form a jetty for the guidance of vessels.

Taking into account the value of the work already executed, and pricing the work yet required at the rates at which the comparatively small works of the last three years have been carried out by the new company in the isthmus of Panama, it is estimated that the canal can be completed, equipped, and opened for traffic at a cost of £20,000,000 sterling, or $100,000,000, including the cost of administration as well as interest paid out of capital during the period of construction.

The time required for completion, if all things go well from first to last, and if serious *contretemps* do not arise, will be about eight years. So uniform good fortune, however, does not often fall to the lot of constructors of public works ; it is therefore proposed to add 25 per cent. for contingencies, making the estimate of time required for completion ten years ; *i. e.*, if the constructible work is proceeded with vigorously from the present time, the Panama canal will certainly be opened to the traffic of the world on New Year's Day, 1909.

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* In the desire for the entire elimination of the personal element from these articles, allusions to the names of individuals have been avoided. Competent critics, both in England and America, will, however, accept the results of these calculations more willingly if we add here the statement, that the calculations throughout have been made by General H. L. Abbot, late of the United States corps of engineers.

THE DEVELOPMENT OF WOOD-WORKING MACHINERY.

By John Richards.

FEW people realize, in the multifarious forms of industry carried on around them, the extensive portion that comes under the head of wood-conversion. Of the three principal materials of construction,—wood, metal, and stone,—wood is the most extensive and conspicuous, wrought into a thousand shapes of use and ornament, and performing a wide range of structural functions. It meets one's view wherever the eyes are turned, and not only is the most familiar of all natural substances in an artificial state, but, next to earth itself, is the most familiar of all objects in its natural state.

Down to a century ago wood was not only the principal structural material, but almost the only one that engaged attention in the common mechanic arts. The carpenter, millwright, engineer, and shipbuilder wrought principally in wood, and, when the penitentiary system was introduced in England about 1790, the only branch of industrial work carried on in the prisons was wood-working. Some accounts of this will be given further on.

The importance of a structural material of any kind diminishes in popular estimation when the tendency is away from, instead of towards, it. New material attracts attention far beyond its real importance. We are scarce beyond the period when aluminium engrossed public attention as a structural material, and gave rise to extravagant fancies out of all proportions to the modest place this metal now holds. It was the last; but for two centuries past there has been a constant search, to some extent successful, for substitutes for wood. Yet it remains the chief material for structural uses, or at least is the most common and useful—the one that could least be spared, and without which the whole domestic economy of life would have to be changed.

Considering these circumstances and the antiquity of the art, we would naturally expect the implements and processes in wood-working to be the most advanced of all. This is not the case, however. The age of the art has little to do with progress in this direction. The application of machine-processes was contemporaneous in all kinds of industry, or nearly so, and is little more than a century old, —a fact hard to realize at this day, when hand-work has so nearly disappeared. The steam engine as a motive power came in with this century, and there are yet living about Soho, in England, men who in their childhood saw James Watt and the factory where steam power had its practical origin.

It seems, too, that the hand-processes in wood-working, an art universally known, offered a resistance to machine-processes greater than that which was met in many other branches. It must also be remembered that many branches of industrial art had their origin in machine-processes, and so were spared the task of displacing traditional customs and skill; hence the progress of wood-converting machines was less rapid than the application of new implements in many other branches, such as metal working and the conversion of fibrous materials.

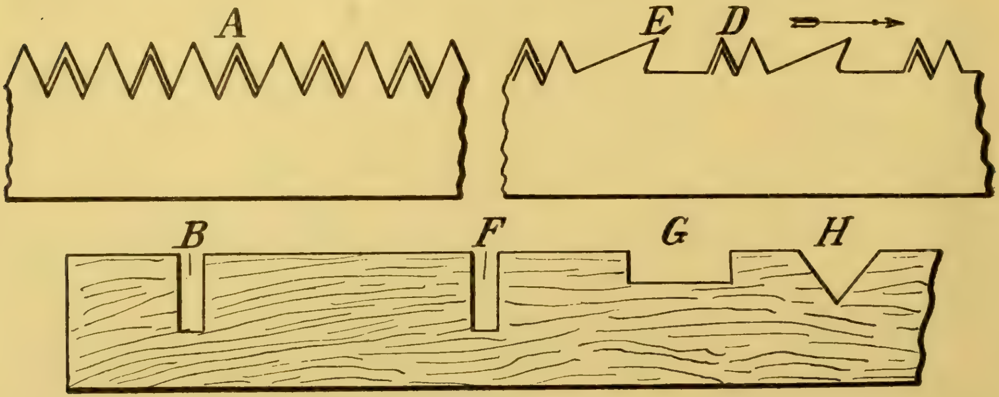


FIG. I.

The principle, or manner of operating, in nearly all wood-converting processes is that of cutting, or by edges—the cleaving wedge, so to call it; the edge being so impelled and guided as to cut away the surplus material and leave the finished form required. There are other processes, such as abrasion, bending, and embossing, but "cutting" comprises nearly all.

There is a near analogy to metal-working, in which the machines and implements are directed to cutting away surplus material, producing planes, cylindrical forms, and sometimes irregular forms; but the operating conditions are different. In cutting and shaping metal by means of edges, a limitation of rate is found in temperature. The material is homogeneous, and can be cut alike in all directions, but only at a slow rate, because of its hardness and the heat generated, which must have time to pass away, by convection and otherwise. Cutting edges rarely move more than ten to twenty feet per minute when acting on iron or steel. The process is slow and expensive, accordingly.

In wood-cutting by machines there is, however, no such limitation. The material is soft, and the movement of edges can be from two to four thousand feet per minute, or as much as the cutter-supporting devices will permit with safety. The product, or area prepared by machine-cutting, is in proportion, and the result far beyond what inference or conjecture would suggest. For example, a surface planing machine operating on both sides of boards 16 inches wide at the rate of 33 lineal feet per minute will prepare and thickness more than 50,000 superficial feet, or one and two-tenth acres, of surface in ten hours.

The economic effect of this becomes apparent, when it is contrasted with hand-work. To operate such a machine requires about 10 h. p. and two attendants. The fuel is furnished by the chips or shavings. Maintenance, oil, etc., at fifty cents a day, represents a fourth of one man's wages, making the whole expense equal to the wages of two and a fourth men. By hand-work these men could plane and thickness not more than 300 feet a day, in a much less perfect manner; so the machine will do 166 times as much work.

In preparing matched, or tongue and groove, work, such as flooring and ceiling, the difference is greater,—not less than 250 to 1,—and in making mouldings not less than 300 to 1. In sawing, turning, mortising, and other operations the same remarkable gain over hand-work appears.

The short period within which these results have been attained is appreciated when we consider that there are many people now living who can remember when joiner work, including even flooring and ceiling, was nearly all planed by hand,—a laborious process that did not in most cases include thicknessing, and was consequently an inferior method, except perhaps as to finished surfaces; and even this exception is not to be made in comparison with the fixed knife planing machine employed in Europe and, more notably, with smoothing machines invented in the United States.

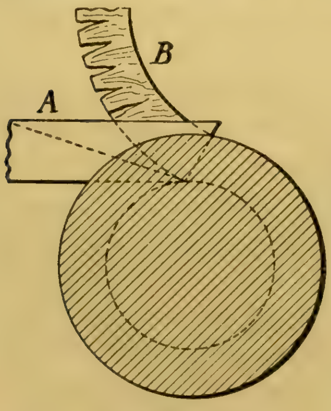


FIG. 3.

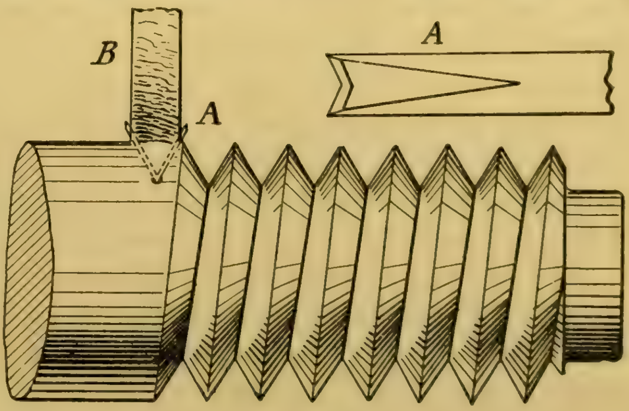
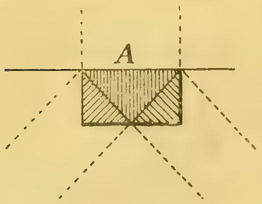


FIG. 2.

Measured by manual energy, which may be taken as 2,500 foot-pounds, or one-thirteenth of a horse power, for a strong man, it would take 130 men to equal the planing machine before named; but there is a difference in favor of the machine in the guidance and application of the cutting edges that justifies the ratios before named.



These comparisons convey an idea of the extraordinary economic results of machinery attained in the principal processes of wood-conversion. They seem incredible, but there are no longer means of comparing, because values are now adjusted to the machine-product alone, and hand-work no longer exists.

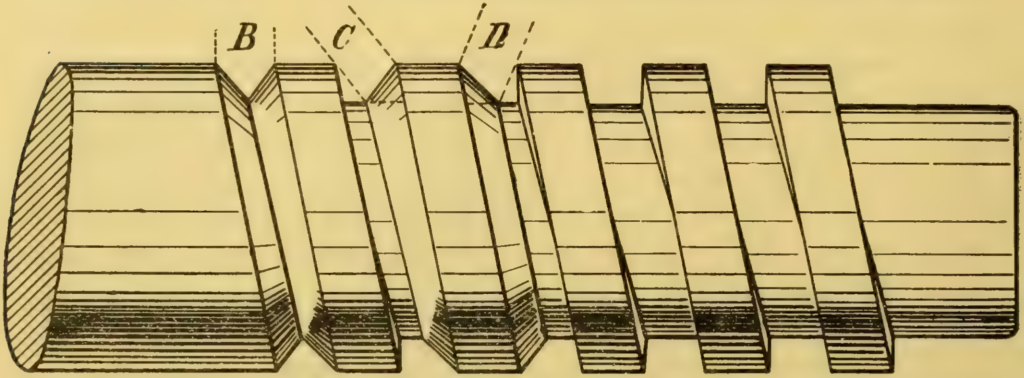


FIG. 4.

These results of machine-processes are, of course, not uniform. The functions of machines are not confined to the application of power. In some cases their dynamic effect is much less than that which a man can achieve, and machine action is confined to accurate guidance, or the production of true forms, as in the making of small articles, like spools and whip-stocks; but such cases do not alter the general result. Indeed, the gain by guidance in such work equals, if it does not exceed, the gain by power in the heavier operations.

The economic effects produced by such a revolution as this in one of the chief branches of human industry, within a century, has been a chief factor in what we call modern civilization; is accountable for many of the changed social relations of our time; and is, in fact, so extensive that no one can trace its effects. It is evidently nearing culmination. This is proved by the slow gain in machine-effect now going on, and a gradual approach toward standard and uniform practice in making and operating machines.

It is customary to predicate the future upon the past, and to assume that the rate of progress in manipulative processes will go on. This might be true if machine-processes came about as a matter of natural evolution, but such is not the case. Machine tools are a "discovery" that moved with cumulative advance for a period; then began to crystallize into a system of uniformity; next, by organized production, began to divide into special machines; and now proceeds by slow degrees on a "narrow margin," as it is called. There is improvement all the time, but no longer revolution.

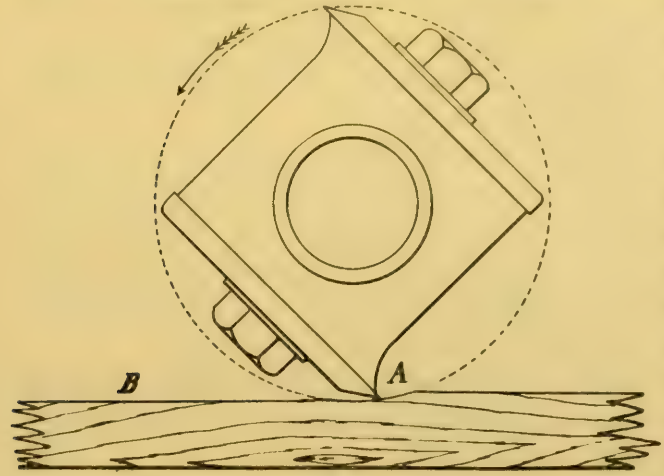


FIG. 5.

The first machine or power operations, it appears from such records as are available, were carried on in Holland, beginning about the middle of the last century, and were confined to sawing machines, especially in preparing ship timbers and fittings, an industry then extensively carried on in that country, as it is still, modified by the progress of engineering.

Circular and other saws were made and used, but to what extent and in what manner it is difficult to ascertain from any accounts in our language. Rotary saws driven by power were introduced into England about 1777, as shown by patents granted at that time,* but there is no evidence of rotary cutters being employed for shaping as well as dividing wood before the subject was taken up in England in 1790 by Sir Samuel Bentham, who devised and practically made and applied nearly all the principal machines now used in wood-converting processes.

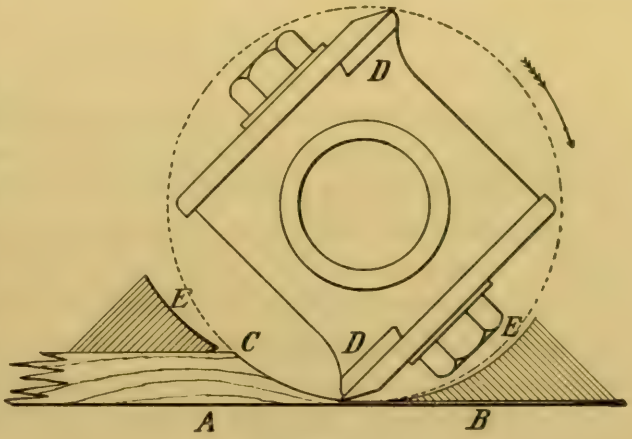


FIG. 6.

Sir Samuel Bentham was unquestionably the most skilled constructing engineer of his time, not only in devising implements to perform various industrial operations, but in discovering the nature, limitations, and possibilities of such operations, or their "analysis," it may be called. His title was that of inspector-general of dockyards, an office created especially to call his qualifications into use, and which expired with his term of service. Previous to his appointment to this special position, he had, under a commission from the emperor of Russia, erected various works in that country for the manufacture of glass, cordage, and other commodities, and had also, while there, turned his attention to a machine for planing wood, which he patented in England in 1791. This machine was, however, a reciprocating one, and was soon abandoned.

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* *Vide* British Patent No. 1152, of 1777.

General Bentham's main invention and discoveries in wood-converting machines came about in a singular manner. His brother, Jeremy, the author of Bentham's "Jurisprudence," proposed and carried into effect in England the penitentiary system for prisons, now spread all over the world, the especial feature of which is to employ the prisoners at some kind of productive labor.

At that time wood-working presented the only field suitable for such labor; but it was foreseen that unskilled men could not perform successfully even the coarser kinds of mechanical work, and Sir Samuel Bentham was called in to devise machines whereby the unskilled prisoners could work in wood. A factory to make such machines was established in London at Queen's Square place, Westminister, Mr. Jeremy Bentham's residence, and another at No. 19 York street, in the same vicinity, where were made a great variety of wood-working machines, at first for the prisons, and afterwards, by direction of the government, for the dockyards at Portsmouth and elsewhere.

These machines are fully described in Bentham's patent of 1793, No. 1951, now out of print, and no doubt, all things considered, the most remarkable patent on implements ever granted by the British government. In a Crown trial at law in 1848 there occurs the following remark by the justice, in his summing-up of the case:

"Sir Samuel Bentham was the first to introduce saw-mills into our national arsenals; the first also to lay down the principles of all kinds of machine saws that may be constructed, and which have never since been materially departed from. The specification of his patent of 1793 is a perfect treatise on the subject; indeed, the only one worth quoting that has to this day been written on the subject."

In 1852 Prof. Willis, in a lecture delivered before the Society of Arts in London, in speaking of Bentham's inventions and machinery, said:

"There were constructed machines for all general operations in woodwork, including planing, moulding, rebating, grooving, mortising, and sawing, both in coarse and fine work, in curved, winding, and transverse directions, shaping wood in complicated forms, and that further, as an example, that all parts of a highly-finished window-sash were prepared, also all the parts of an ornamental carriage-wheel were made, so that nothing remained to be done by hand but to put the component parts together."

These machines, as Professor Willis indicates, were for sawing, planing, mortising, and working wood in straight, circular, and irregular forms, for making cabinet ware, carriage wheels, and other things of the kind; they were made and furnished to the government and applied in the penitentiaries and dockyards, the accounts showing that the sum of £16,000 was paid to Bentham for such machines, and that a further sum of £20,000 was voted to him as a premium, estimated to be the saving effected by the machines for one year in the dockyards alone.

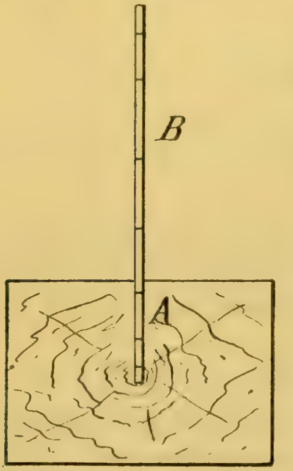

FIG. 7.

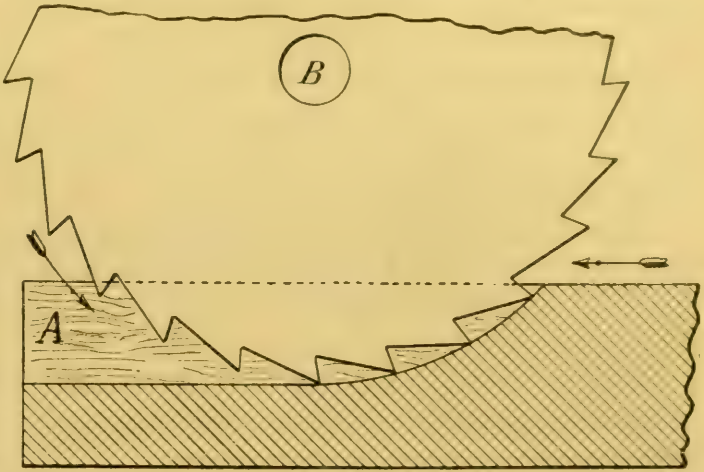

FIG. 8.

These machines included the celebrated block-making machines yet in use at the Portsmouth dockyard, of which the government had models made and deposited in the Kensington Museum at London about twenty years ago. These machines, which the writer examined at Portsmouth in 1872, are remarkable examples of ingenious design. They were made about 1790 by Sir Samuel Bentham, assisted by Isambard Brunel, the elder of the two noted engineers of that name, who devised the machines for "turning block shells,"—the most ingenious of all in the set, or system.

A considerable space has been devoted to this account of General Bentham's inventions, because of their extraordinary character and the equally remarkable fact of their being absorbed by the government instead of passing into common practice. One hindrance, no doubt, was the comprehensive patent granted to Bentham in 1793, and the inability of people at that day to understand so sweeping an innovation in a manufacture previously performed by hand; another was the antagonism of workmen, who burned the first saw mills erected in London.

In 1802 followed the implements of Joseph Bramah for wood planing. This invention relates to what are called transverse planing machines, in which the axis of the cutter's revolution is normal to the faces acted upon, commonly known in the United States as "Daniels planing machines." The Daniels machines differed from those of Bramah in the important feature that the cutter shaft was suspended centrally above the timber to be planed, so that the cutters could operate over a width equal to their whole sweep, while in the Bramah machines the cutter shaft extended below the timber at one side, the cutters operating over less than half their sweep and in a less favorable manner.

The American improvement was important; the machines spread all over the country, and are yet in use where accurate work is required. Further explanation of the action of these machines will be given later.

Six years afterward William Newberry, of London, invented band-sawing machines, and, in a patent granted to him of that date, illustrated his invention in a complete manner. The machines had iron frames, canting tables, feeding rollers, and devices to guide the material. A drawing of this machine will be given hereafter.

This was a complete conception of the band saw, and to the inventor must have given hopes of revolution in sawing processes; but he was doomed to disappointment. The invention had to wait for the inevitable course of evolution, which required in this case more than two generations and is not completed yet. When we consider how simple this invention is,—that of an endless strip of steel stretched over two pulleys,—it seems as though it should be completed, perfected, and applied at once. It affords us a lesson in the limitations that confine human powers, in even the simple branches of constructive art.

The saws themselves were the principal impediment, although the apparently simple machine itself has passed through a long train of modifications, as will be hereafter explained. Newberry's invention of band saws is the first of which clear records exist, but there is no doubt that the same thing has been invented many times and in various countries.

In 1822 there came from several sources the invention of duplicating, or pantagraph, machines that grew into an extensive and important class employed for irregular forms, such as shoe-lasts, gun-stocks, spokes for wheels, implement handles, and the like. In the British patent office, which forms the storehouse of inventions for two hundred and fifty years past, the pantagraph principle in machines is traceable to Blemchase and Boyd, and later to Blanchard in the United States; but none of these inventors anticipated James Watt, the celebrated steam engineer, who not only invented pantagraph machines about 1816, but made them in the most perfect form, capable of the finest work, such as carving medallions.

Mr. George Tangye, manager of the Cornwall Iron Works, of Tangye Brothers, of Birmingham, England, about 1876 leased the old Watt homestead at Fairfield, near Soho, a suburb of Birmingham, and entered into a bond, as a predecessor had done, to preserve the old private workshop of James Watt; so it now stands just as James Watt left it at his death in 1819.

This room remained intact, even to the embers left in the grate and Watt's old pipe lying near, in 1876, when the writer, then residing in England, had the good fortune to be invited by Mr. Tangye to visit Watt's room.

It would be foreign to the present theme to enter upon a description of this room here, further than to say that the pantagraph machines are the most conspicuous of all the hundreds of implements and devices there gathered. It was the last thing that engaged the attention of the great engineer. A full-sized pantagraph, or copying machine, occupies a central position in the room, and on the table of this machine is a partially-completed figure cut from an original of three times the size.

The application of this process to various irregular forms was undoubtedly Watt's intention, and this would have been far less difficult than the processes he had carried out at the time he was suddenly stricken down.

There is a rumour, yet traceable among the people about Soho, that Watt ascertained before his death that the pantagraph, or duplicating, system of operating had been discovered and applied in France; but the author failed to find in the Museum des Arts et Métiers at Paris any account of such an invention,—a fact not at all conclusive, however, because of the lack of classification. Such a lack is astonishing in a French institution, the French people usually leading all others in organization and orderly methods.

From this point the evolution of wood-working machines was shifted from the old to the new world. For a period of thirty years or more but little progress had been made in England in the improvement of wood-working machines,—a matter of surprise when we consider that it was during this time that Whitworth, Bodmer, Nasmyth, Clement, and others produced types of metal-working implements that have been but little improved to the present day.

The development of wood-working machines in the United States, beginning about 1844, was confined to what may be called "finishing" machines, made at Keene, N. H., and at Norwich, Conn., by the progenitors, as they may be called, of the present firms of C. B. Rogers & Co., of Norwich, Conn., and J. A. Fay & Co., of Cincinnati, O. Planing machines for surfacing, matching, and moulding had a nearly contemporaneous development in the Woodworth, Farrar, and Daniels machines.

The American machines were neatly made with wooden frames, and were fitted with an honest care not always emulated at the present day. The makers did their work well; the machines were cheap and suited to the wants of the times and the diffused state of the industry, then carried on in numerous small shops all over the country.

In 1852 the American makers above named, with commendable ambition and in view of foreign trade in their machines, took a number of them to the World's Exhibition at the Crystal Palace in London. These machines attracted much attention. They were operated at a speed far in excess of what was then considered possible or safe in Europe. An idea of the impression they made can be gained from the fact that Sir Joseph Whitworth, then the most famous constructing engineer in England, was commissioned to make a report on them. This report was favorable, and led to an attempt to imitate them, at first by copying and later by substituting iron for wood in their construction, with results that modern practice, on both sides of the Atlantic, will disclose in various designs to be illustrated in future.

About 1860 American makers began turning their attention to iron frames for wood-working machines, and to various improvements which this better and stronger construction permitted. At first the homogeneous nature of metal had not been considered, and the iron in frames was disposed nearly as the wood had been,—that is, in rectangular lines and sections,—and, to further embody the joiner idea of construction, mouldings, panels, beads, and ornate shapes were introduced, as well as decoration by painting and varnishing. These things have lasted almost to the present time, and can be detected now in a good many cases, as they could in metal-working machines at an earlier date.

The evolution of these implements has, however, in function, arrangement, and appearance, or, as we say, in "design," reached an advanced stage, and emulation is now in a great degree confined to workmanship and endurance,—qualities that are at first not so much regarded because inconsistent with change. So long as a machine was liable to be superseded in a few years, its fitting and endurance were not matters of much concern. The prices for machines have also much increased, and in many cases, especially in Europe, the weight, quality of workmanship, and precision of construction are the same as those bestowed upon metal-working machine-tools.

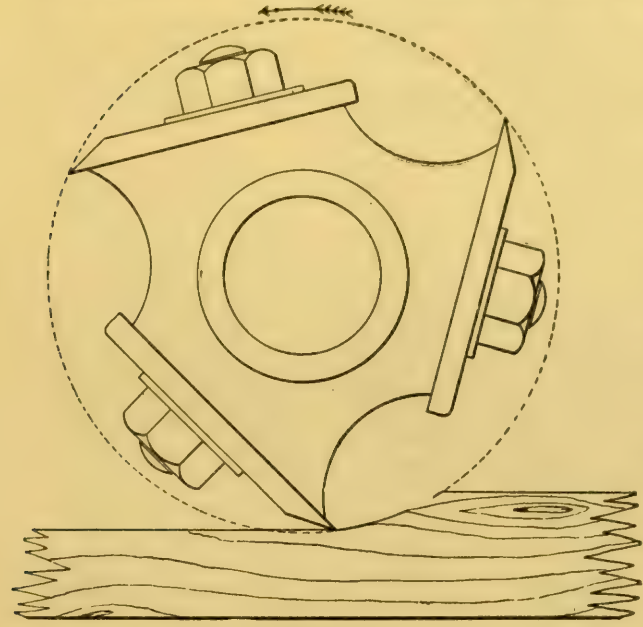

FIG. 9.

A strange circumstance connected with the development of wood-working machines in the United States has been that it did not include in the same degree the principal machines—those for sawing and planing. It stopped with the finishing machines. Planing of joiner work is yet done on an illogical system, not known or practised in any other country, and circular saws are less perfectly mounted and operated, are thicker and more wasteful, and consume more power. The latter is no doubt a result of the cheapness of timber and an economy of labor, but the manner of planing has no explanation that the writer is aware of. The difference in the manner of operating and in results should engage especial attention at this time, in view of a large and increasing export trade in wood-working implements of the finishing class. These differences will be fully considered in connection with the constructive features of the machines; they are mentioned as a feature in the history of the art.

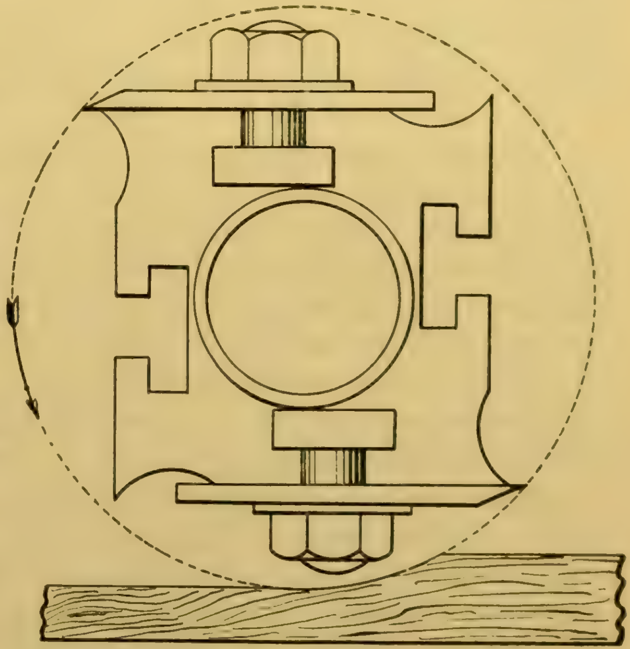

FIG. 10.

Future practice, while it may not be forecast at this time, will certainly tend to an assimilation of design, by reason of international trade in both machines and timber. Some modifications must naturally result from difference in requirements, the price of timber, and a diversity of uses, but these will only serve to cause a more careful study of the action of machines, and emulation will be confined more to skilled production than to particular modes of operating.

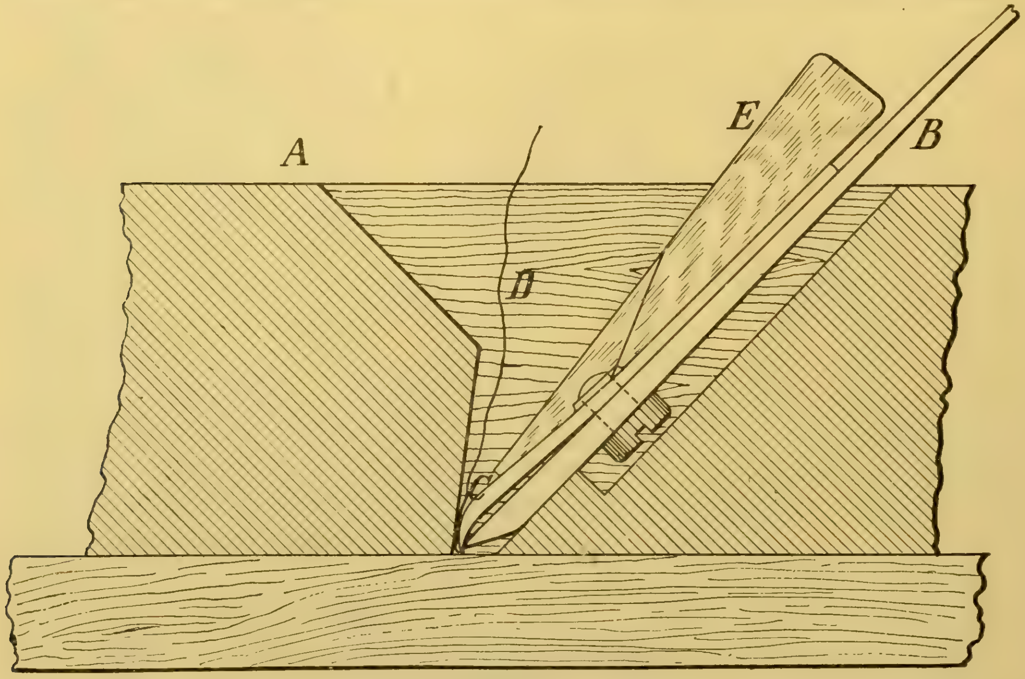

FIG. 11.

Nearly all the operations in wood-conversion are performed by means of cutting edges, but not always under the same conditions. Wood, unlike metals, is of a fibrous or laminated structure, built up of growths, longitudinally, that have but little strength or coherence laterally; and, as cutting must be done each way of the lamination, or grain, as it is called, this divides wood-cutting implements into two classes,—one to operate transversely, or cross-cut, and the other to operate longitudinally. In the operation of saws the longitudinal work is called "ripping."

It may be pointed out that saws, while they form two types of a distinct class of wood-cutting implements, do operate as other kinds, with the difference that saws are to cut narrow channels and are employed to "divide" material, while other implements are employed to "shape" materials. There is also the distinction that saws have usually their cutting edges formed integrally with their supports, or the saw plate, while other implements have detachable cutters.

Two broken sections of straight cross-cutting saws are shown in Fig. 1; also a piece of timber scored with these saws. One of these, A, has lance teeth, all of one kind, cutting a groove or kerf angular in the bottom, as seen at B. The other saw, C, has pairs of lance teeth, D, to cross-sever the fibre, and chisel teeth, E, that split out the wood, leaving a flat bottom in the kerf, as seen at F. This method is technically called "dado" cutting, and is applied in various modifications to forming grooves and rebates transversely to the fibre.

To further illustrate this cross-cutting process, if one attempts, with any kind of implement, to cut a rectangular notch in a piece of wood, as at G, it is evident that, if the piece cut out is inflexible, there will be no place for the cutting edges at the sides, or shoulders, and the chips will jam. A tool with three sides cannot be used transverse to the fibre, but, if the cut is to be triangular, as shown at H, the fibre is split off by the wedging action of the edges at the sides of the implement, as in chopping with an axe, and is free to rise out of the tool. One of the best illustrations of this method of operating is in cutting angular and square threads on wooden bench screws.

This is illustrated in Figs. 2 and 3. In Fig. 2 a single V tool, A, will cut out the whole channel at one operation, because the chips, B, are free to split off and rise out of the tool as soon as the sides are severed in advance. In cutting the nuts it is better to divide the work between two, or even three, tools of the same shape operating at different depths, but the action is the same. Cutting square threads in screws, as shown in Fig. 4, is a more difficult operation, but is done in the same manner,—that is, the wood is cut away in three triangular sections, as indicated by shading at A and by the notches, B, C, and D, showing the successive stages of removing the wood. These examples illustrate the various operations of cutting wood across the grain; it may be added that the cutters should have a shearing action,—that is, the edges should lean forward and sever the fibre in advance, at the surface.

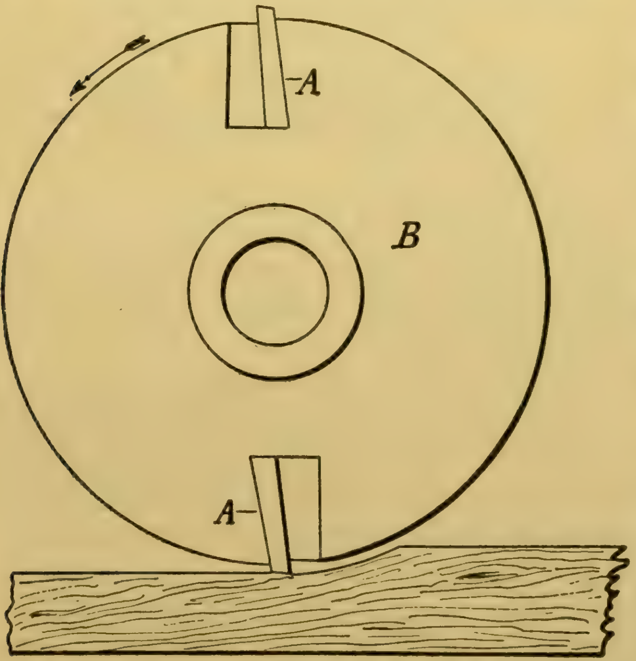

FIG. 12.

Fig. 5 shows an example of longitudinal cutting with rotary knives, producing a slight smoothing cut, the reduction at A being only to make a face. This illustrates in a general way all the operations called planing with rotative cutters to produce planes, as at B, and reduce the wood to a uniform size.

In Fig. 6 is shown an extreme example of reduction at one operation,—a piece of hard walnut wood cut down at B to one twenty-fifth of the depth at C, or from 0.5 to 0.02 inches. This example is from a number of experiments made on the Whitney planing machine, and has been forwarded to the editor of The Engineering Magazine, lest the statement may be questioned. The principal feature in producing such a result is the general perfection of the machine's action, especially of the pressure bars, E and F, that maintain the reduced section, B, and prevent splintering at C.

In rip-sawing, grooving, mortising, and like operations the lateral separation of the fibre is not performed directly by the edges. It is torn or pressed off by force, and is not cut. For example, Figs. 7 and 8 show side and end views of a piece of timber having a groove or kerf, A, cut out by a circular rip-saw, B. By comparing with Figs. 5 and 6, it will be seen that the operation is just the same, except that the shavings have to be split off at their edges, which amounts to little in this case, because of their thinness. The saw, B, has teeth that are plain cutters of chisel form, acting successively, each cutting out a shaving as a planing knife does.

Fig. 9 shows a planing head,—commonly called, when long, a "cylinder,"—arranged for three knives, and Fig. 10 a moulding head to receive two or four cutters, not drawn from special examples, but to show in general the manner of mounting and supporting cutting implements for operating longitudinally.

Another expedient in wood-cutting is the means employed to prevent "pulling out," or splintering, when operating on cross-grained, knotty, or burl timber.* These expedients include three different means,—namely, the use of caps or back-irons, the selection of the angle at which the knives act, and the adoption of scraping cutters. These methods are illustrated in Figs. 11, 12, and 13. The first, being a cap, or back-iron, as applied in hand-planing, also corresponds to the lips, or guard irons, D, in Fig. 6, which act in the same manner. A is the plane stock, B the iron or knife, C the cap, D a shaving being cut off, and E the wedge to hold the plane iron. The cap, C, is fitted at its edge with great nicety, so as to expose a mere line of edge when the work is fine. The shaving is, by the cap, C, crimped, or doubled back so as to press down and hold the wood in advance of the edge, that it may not splinter or rise. Only a very skilled workman can fit up a plane that will operate on veneers, or on cross-grained, or crotch-wood. In machine cutters, or knives, such caps, or back-irons, are less important, and are seldom fitted as accurately as in hand planes.

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*The term timber is used, because it is the generic name from the old Saxon "Timmer." "Lumber" is an old and useful name, meaning waste or cumbrous material of any kind. There is no warrant, except local use, for applying it to sawn timber.

In Fig. 12 a like result is obtained by the angle of the cutters, A, which are set almost radial on their faces, have thick blunt edges, and are made extremely hard. They operate exceedingly well on all kinds of hard wood, such as banyan, boxwood, rosewood, cocoa, and especially lignum vitae and teak. The last-named, a most obdurate material, is said to contain silica in its pores. Such cutters also work well on ash, oak, hickory, beech, or any hard wood. The heads, B, are commonly made of wrought iron or steel, the cutters being keyed in so as to be supported close out to their edge, and also for safety, because it is convenient to work at double the ordinary speed with one cutter. The writer, who, thirty years ago, when engaged in this line of work, made a good many machines to operate in this manner, much wonders

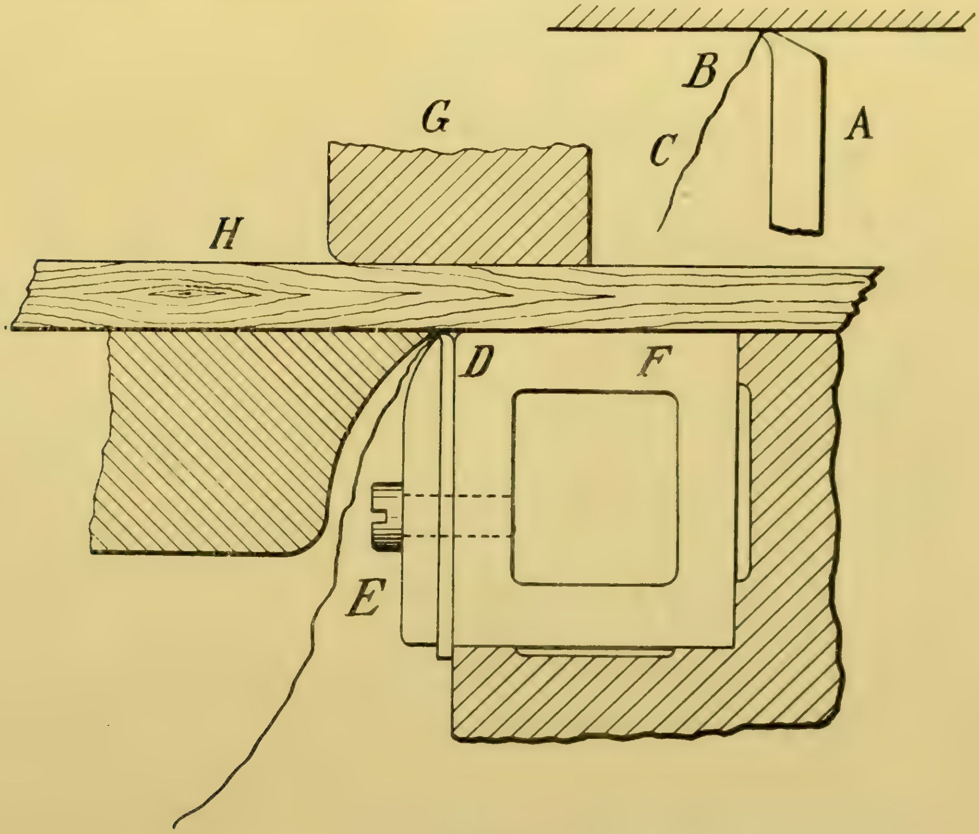


FIG. 13.

that the method has not spread more. The system, in the form shown, was invented or introduced by Mr. J. A. Montgomery, of Columbus, O., about 1855.

The third method—that of the scraper shown in Fig. 13, commonly known in the form of a piece of broken glass—acts like the cutter in Fig. 12, but with a corner having an angle of 90 degrees. The diagram at A is an enlarged section, showing a machine-scraper, sometimes made to cut a clean shaving across a surface 36 inches wide and of any length. The edge, B, is turned by a machine, and is much more perfect than the edges made on hand-scrapers used by cabinet-makers. The shaving cut off is broken or crimped as soon as severed, but on tough wood comes off in a complete sheet, except that it is shortened to a third or half the length of the board from which it is cut. Knots and all kinds of cross-grained wood are cut in the same way, and left with a smooth surface. These machines will be noticed again. The main figure shows the method of mounting these scrapers in a machine. D is the knife, E a cap, F a draw frame carefully fitted across the machine, G a pressure bar, and H the timber being planed.

There are a number of other features—or "principles," as they are called—relating to the action of cutters; these will come up in connection with certain machines, or classes of machines, to be hereafter considered. It will appear that all the various operations in wood-cutting are embraced in these two processes,—namely, scoring or cross-severing the fibre, and cleaving edges that split and shave longitudinally; also that the functions of wood-cutting machines are to hold and impel cutters, and to support and present the material.

THE MINERAL RESOURCES OF CUBA.

By Jennings S. Cox, Jr.

IF we listen to the voice of the charmer, or go to the books on Cuba for our information, we shall find that the mineral resources of this island include gold, silver, mercury, lead, antimony, copper, chrome, iron, manganese, pitch, bitumen, and even coal; but when we look for practical metallic results commensurate with these varied mineral resources we shall be disappointed.

The gold fiction is the most time-honored, for the original Spanish settlers expected to find rich gold mines in Cuba. According to their historians "much gold was taken from this island at the beginning of the conquest," but it seems probable that most of this was taken from the chiefs, or caciques, of the Indians and very little from the ground. "El Viagero Universal," Madrid, 1797, says: "some of this metal (gold) is still found at Holguin." Whenever the existence of gold in Cuba is discussed this "mine" at Holguin is invariably brought forward. It is true that some work has been done at this point and a little gold has been extracted, but there has never been any systematic exploration, and there is nothing there which may be dignified with the name of a mine.

In like manner most of these mineral resources fade away in the search light of investigation, until only copper, iron, and manganese remain. Of most of the others listed above, it is fair and proper to say that they have been found but are not worked. It may fairly be doubted if mercury and coal have ever been found, although "denunciations" of mercury exist.

Copper occurs frequently, in greater or less quantities, in the metamorphic rocks which form a large portion of the island of Cuba. The principal occurrence is as chalcopyrite, in quartz veins in the metamorphic rock, at the village of Cobre, in the mountains about twelve miles west of the city of Santiago de Cuba. The mines at this point were discovered some three hundred years ago and were worked to a limited extent, but always as crown possessions or under royalties to the crown. They were abandoned and had been idle for more than a century when, in 1830, an English company reopened them and worked them systematically and actively, employing as many as 2000 men. A railroad was built from the mines to Santiago bay. The remains of this road still exist.

The railroad was owned by a Spanish corporation, and the mines and railroad became involved in litigation. The railroad company won its suit but "killed the goose that lay the golden egg," for the excessive freight charged by the railroad, the reduced price of copper, the scarcity of labor, and the breaking out of the ten years war combined to close the mines once more.

The extensive plant of the English company—which included what was, in its time, the largest Cornish pump in the world—their crushing and concentrating machinery and buildings, are now nothing but a picturesque heap of ruins.

There is no available record of what these mines have produced, but the deepest shafts were 900 to 1000 feet deep and the underground workings are said to have been very extensive.

To-day cement copper is made in a small way by precipitating in tanks, by means of scrap iron, the copper held in solution in the water that seeps through and drains from the old waste dumps and in the water that fills the shafts. The amount of copper produced in this manner is, however, insignificant.

VIEW SOUTHWARD FROM LOLA MINES, LOOKING OUT TO DAIQUIRI BAY.

MANGANESE MINES.

There are a number of manganese mines in the province, mostly to the west of Santiago de Cuba, which have been worked in a desultory way, the lack of proper transportation facilities making it impossible to operate on any considerable scale, although the ore is very high grade. The Ponupo Mining Company, an American corporation, has built a branch of the Sabanilla y Moroto railway into its mines and, although prevented from working during the Spanish-Cuban war, is now opening its mines and preparing to ship extensively.

AN OUTCROP OF THE SAN ANTONIO ORE-BODY.

IRON ORE DEPOSITS.

The coast range of the island of Cuba near Santiago de Cuba, generally known as the Sierra Maestre, is rich in hematite and specular iron ores.

While it is not within the purpose or scope of this article to discuss in detail the geology of the country, or the genesis of these ore bodies, these may be briefly indicated.

This portion of the island is the result of successive upheavals. The coralline limestone rests on syenite; this syenite has been over-

MINING VILLAGE OF FIRMEZA, JURAGUA COMPANY'S MINE.

HOUSES OF MINE OFFICIALS AT VINENT.

flowed by an immense mass of highly basic ferruginous trap, which has made its way to the surface in numerous dykes.

From this trap the ore bodies of the district have been formed. Great quantities of ferric oxide have been dissolved out by the action of surface waters, from which they have been re-deposited in concentrated form. In many, probably in most, cases the ore bodies are the result of the weathering of isolated bodies of coralline, and their replacement by ferric oxide from the percolating waters. For this

ARMORED CAR IN COMMISSION ON THE RAILWAY. MARCH, 1897.

reason they are without definite walls or regularity of arrangement. They are scattered along the range of hills for a distance of eighteen or twenty miles, but there is no continuity of formation.

The region where these deposits exist was formerly occupied by the plantations of wealthy Spaniards. Everywhere in these beautiful hills can still be seen the remains of the fine roads, shaded by bamboo hedges, over which the proprietors passed in their *volantes*. One of these roads passed through the ore body that is now the Magdalena mine, and was known as the "black road" because it was practically pulverized iron ore. These rich old grandees must have known, but apparently did not realize, what lay at their feet, and it was actually not until the year 1861 that the first claim was located, or "denounced." Since then more than two hundred locations have been denounced in the Sierra Maestre, both to the east and west of the city of Santiago de Cuba.

TRACK DEPOSITS AND INCLINE. SAN ANTONIO MINE IN THE CENTER.

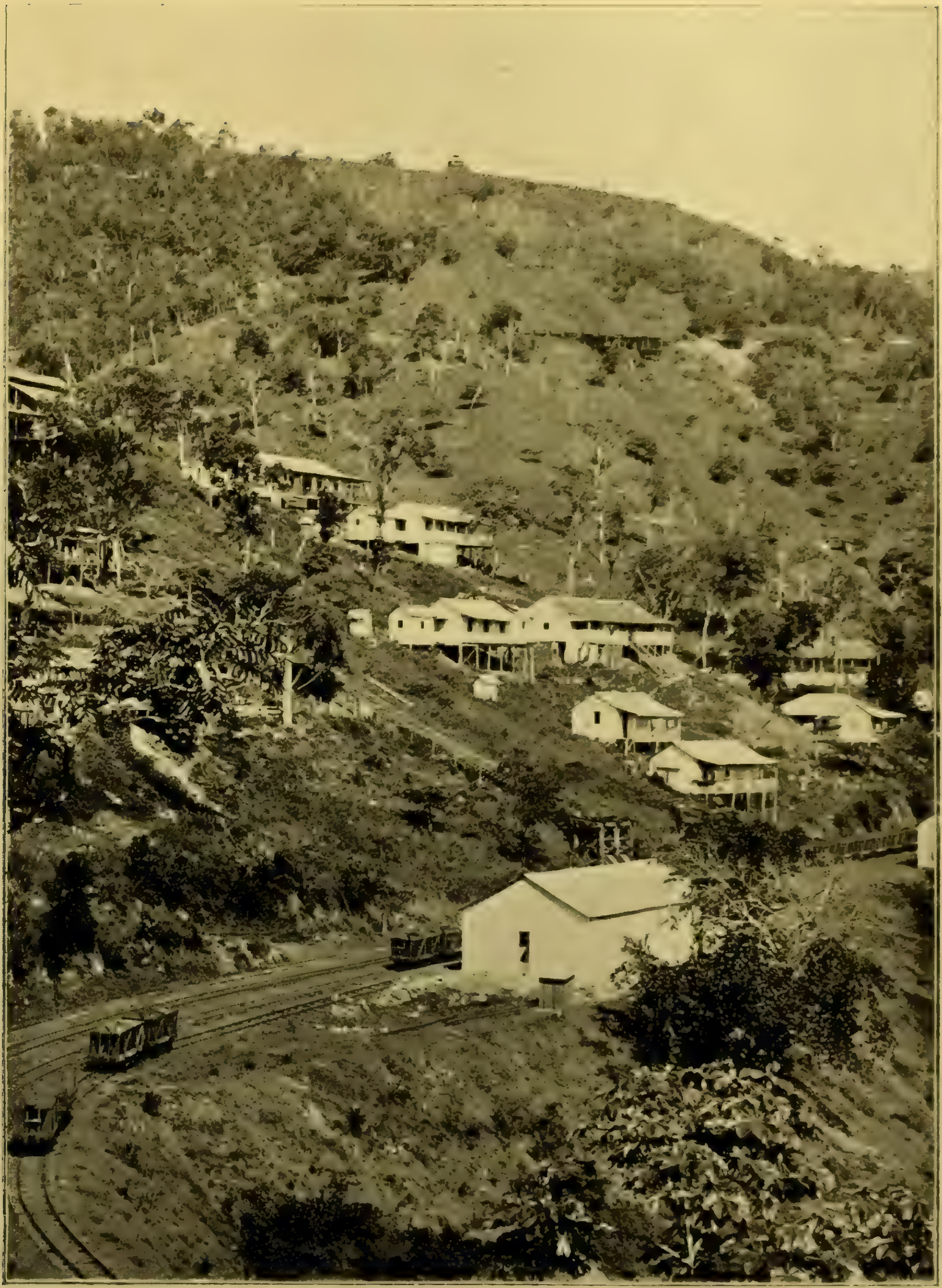
Of these denouncements, the most important and, in fact, the only ones that have ever been worked are to the east of the city, covering a distance of twenty odd miles along the range a few miles in from the coast. As has been stated, the deposit is not continuous, but there are numerous separate deposits along the distance, some of them being very extensive.

In order to encourage the mining of this ore, the crown of Spain issued on the 17th of April, 1883, a royal decree to the following effect: That for a period of twenty years from that date, the mining companies should be free from all tax on the surface area of all claims of iron or combustibles; that ores of all classes should be free from all export taxes; that coal brought in by mining companies for use in their work should be free from all import duties; that combustibles as well as iron ore, should be exempted, from the 3 per cent. tax on raw materials; that mining and metallurgical companies should be free from all other impost; that, for a period of five years, the mining companies should be exempt from the payment of duties on all machinery or materials required for working and transporting the ores; that vessels entering in ballast and sailing with ore should pay a duty of five cents per ton navigation dues, and that vessels entering with cargo destined for the mining companies should pay $1.30 per ton navigation and port dues on all such cargo, and on the remainder of the cargo as per general tariff.

Encouraged by the liberalty of this royal decree, the Juragua Iron Company, Ld., a Pennsylvania corporation which had secured by purchase and leasehold a valuable group of mines, at once commenced the construction of a railroad twenty miles long, from their mines at Firmeza to Santiago Harbor, where they built an ore dock and, by remarkable activity and energy, succeeded in shipping their first cargo of iron ore in 1884. The success of this enterprise caused every one who owned a "denunciation" or claim anywhere along the range to "mark it up," and the price of claims and lands rose greatly; but no new investors appeared for several years.

Mr. Samuel P. Ely, of Cleveland, Ohio, purchased in 1889 the

HARBOR OF SANTIAGO, AND PIER OF THE JURAGUA IRON CO.



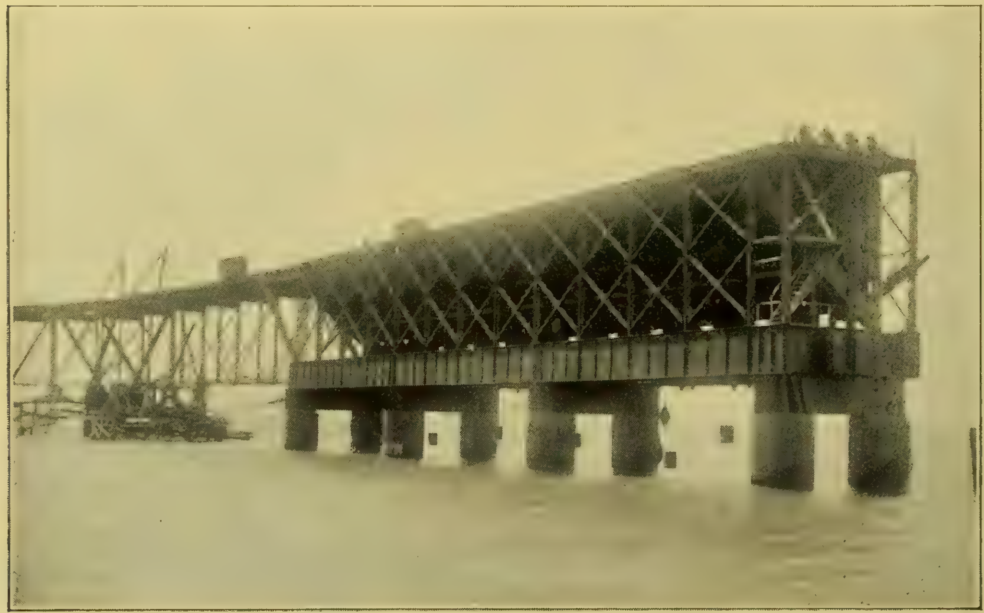
VILLAGE OF FIRMEZA, AND JURAGUA COMPANY'S MINES.

mines known as the Lola group and organized the Spanish-American Iron Company. These mines are several miles to the east of the Juragua group and no attempt was made to connect them with Santiago. A railroad was built directly to Daiquiri bay, an open roadstead on the Caribbean sea. Here a considerable engineering problem presented itself in the question of a proper shipping pier or dock.

It was proposed to build a breakwater and sink wooden caissons, filling them with concrete to form piers for an ore dock. A caisson 30 ft. in diameter was gradually sunk to a depth of about 30 feet in sand, when it rested on large boulders and could not be sunk further.

The work of filling in the concrete was begun, but on the same day a great storm arose and in a few hours every vestige of more than a year's work was carried away. This project, including the breakwater, was then abandoned.

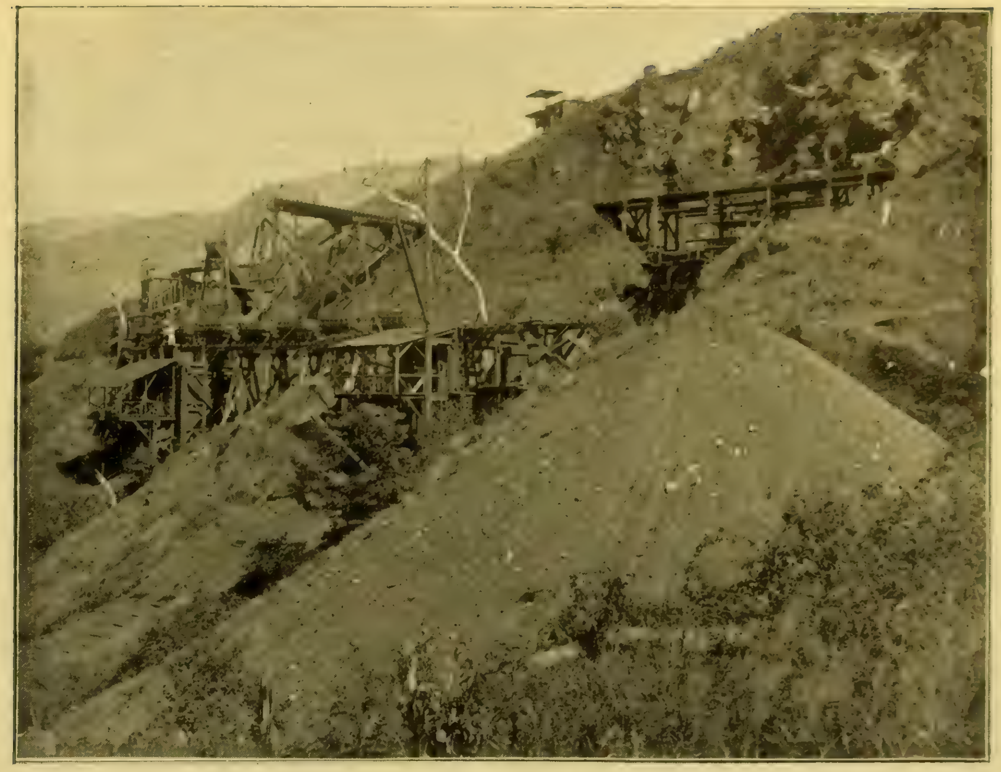
It is characteristic of engineering science that its failures are but stepping stones to success; work was immediately begun on a new dock. This time ten iron cylinders, ten feet in diameter, were sunk to bed rock and filled with concrete. The cylinders were arranged in pairs, twenty feet centers, the pairs about 67 ft. apart. Four pairs support a steel ore dock, similar to those in use in Lake Superior, and the fifth pair forms the pier of the bridge approach. The dock is a substantial monument of engineering skill and has thus far withstood the severest storms.



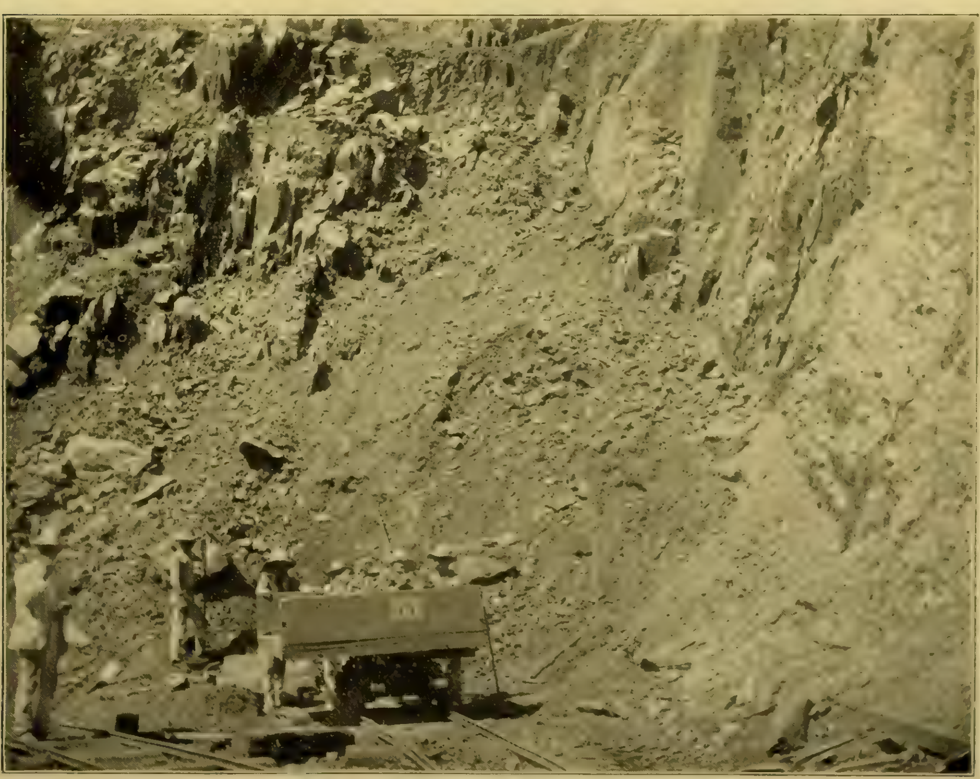
THE ORE DOCK AT DAIQUIRI.

Various delays retarded the work of this company, and it was not until May, 1895, that the first cargo was shipped.

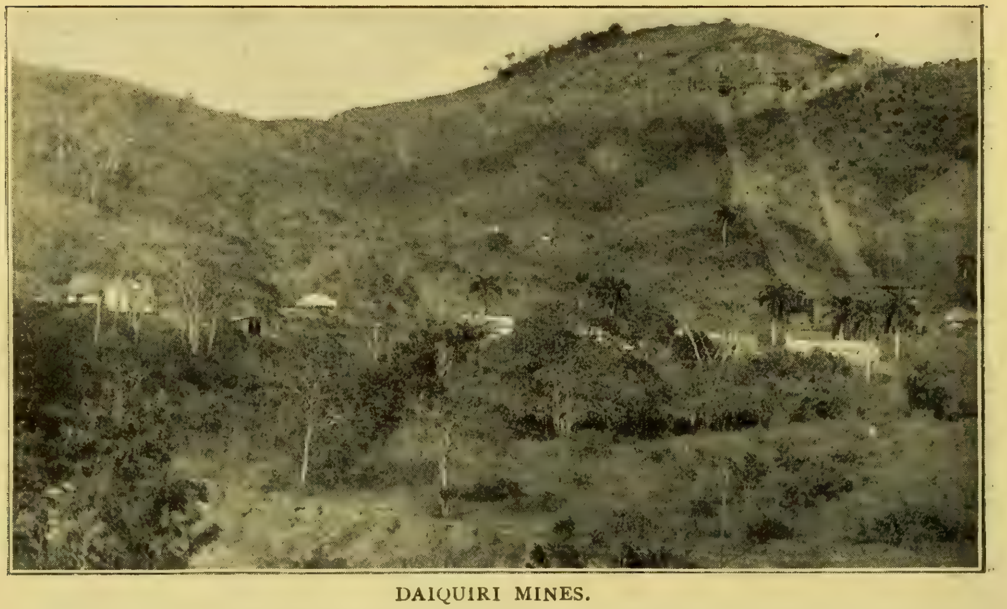
A third American company, The Sigua Iron Company, had meanwhile purchased a large tract of land and numerous claims some miles east of the Lola group, and at Sigua Bay, more sheltered than Daiquiri Bay, a breakwater was built and a wooden ore dock was erected. This was connected with the mines by a railroad nearly nine miles long. Some two millions of dollars were expended here and 12,000



THE LOLA MINE.



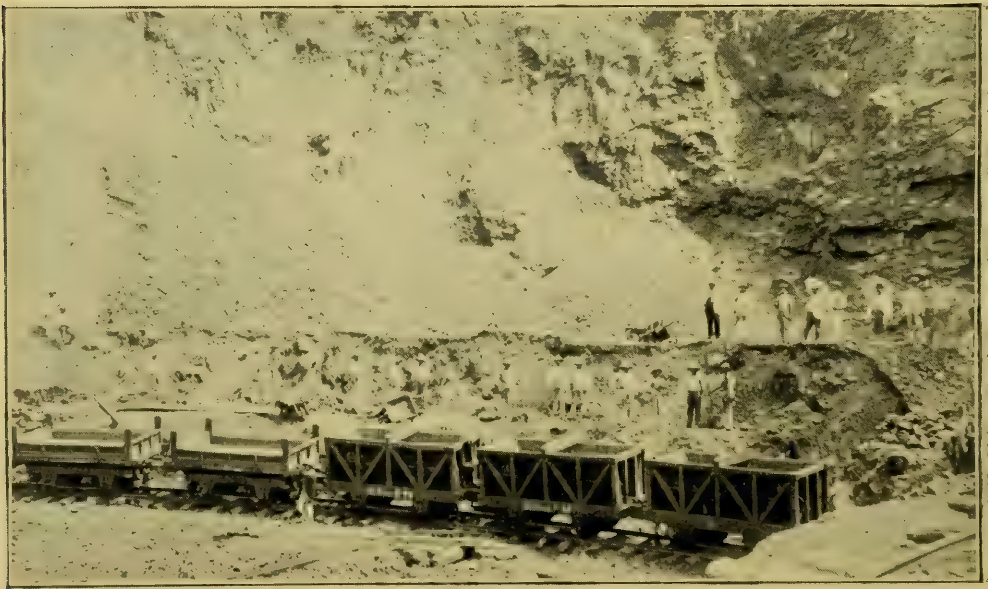
WORKING FACE OF ORE BODY, LOLA MINE.



DAIQUIRI MINES.

tons of ore were shipped when all work was stopped for lack of ore. The mines were in a watchman's care during the insurrection, but at Sigua bay the docks, shop, and buildings were all destroyed; the railroad embankments in many places have been carried away by the floods and only the wreck of these extensive works remains.

The Spanish-American Iron Company and The Juragua Iron Company remained in operation during the entire war between Spain and Cuba, and, although located on the extreme outpost of the Spanish troops, and with Cuban forces in the immediate vicinity, maintained throughout a strict neutrality, and continued shipping ore until they



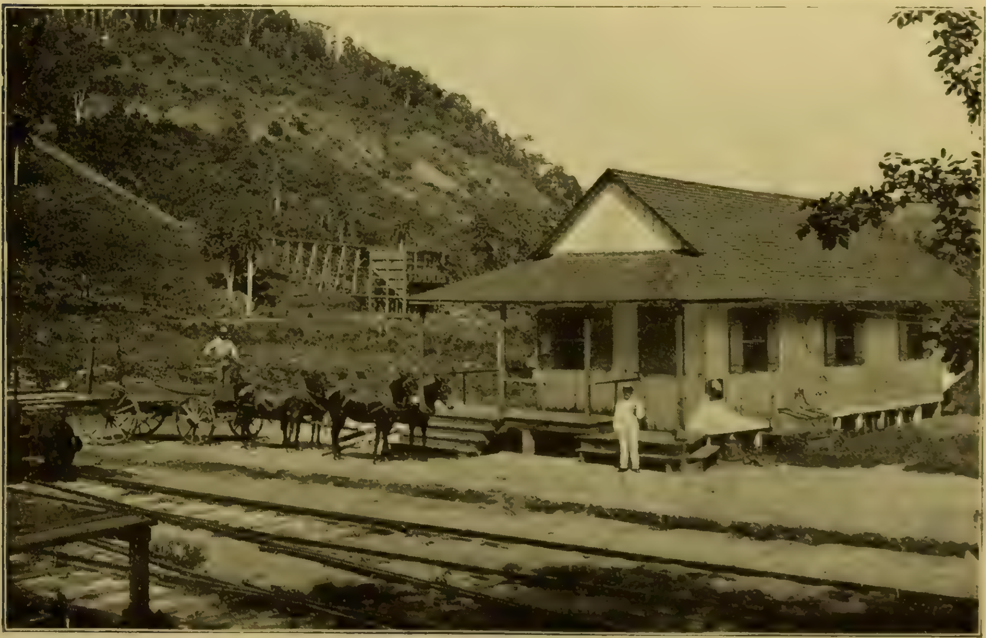
WORKING FACE IN THE JURAGUA MINES.

were closed by order of the Spanish authorities after the declaration of war between the United States and Spain.

The three iron companies mentioned, which are the only ones that have ever operated mines in the province, represent an investment of American capital of about $8,000,000.00, and the two still operating have paid into the treasury of the United States more than $2,000,000.00 in import duties on iron ore.

The following table shows the production of iron ore in the province from 1884 to 1897.

	Juragua.	S. A. I. Co.	Sigua.	Total.
1884	23,977	......	......	23,977
1885	80,095	......	......	80,095
1886	110,880	......	......	110,880
1887	94,810	......	......	4,810
1888	204,475	......	......	204,475
1889	255,406	......	......	255,406
1890	356,060	......	......	356,060
1891	261,620	......	......	261,620
1892	320,859	.....	......	320,859
1893	334,341	......	12,000	346,341
1894	153,650	......	......	153,650
1895	302,050	74,991	......	377,041
1896	291,561	114,110	......	405,671
1897	246,530	206,029	......	452,559
Total	3,036,314	395,130	12,000	3,443,444

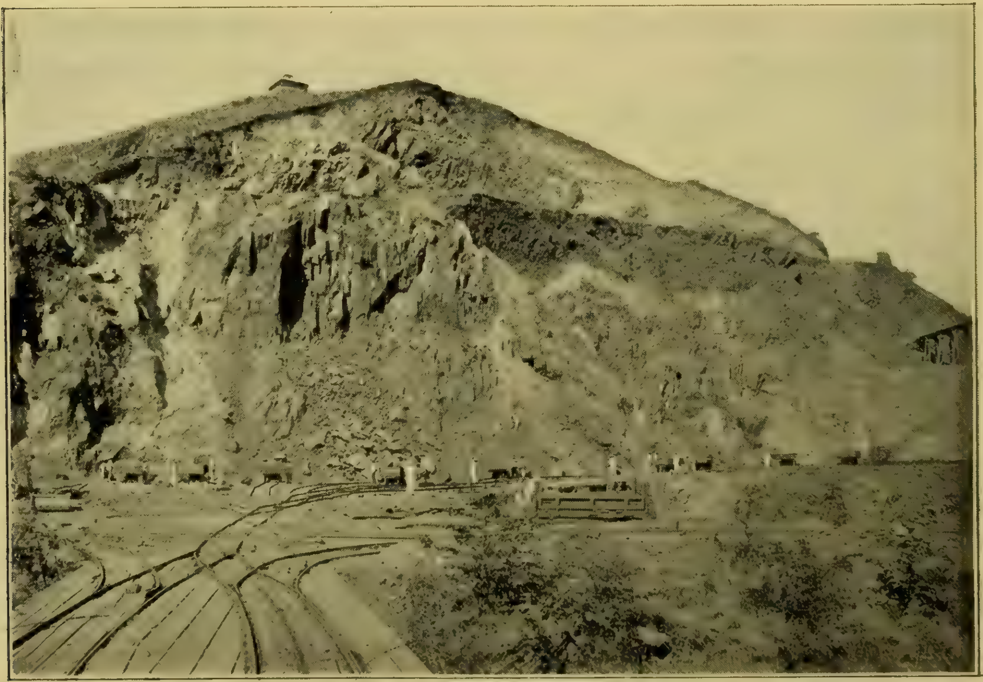


SAN ANTONIO MINE AND OFFICE.

The ore is found in isolated bodies without definite walls, and generally near the tops of a range of hills, two and a half to four miles directly back from the coast. There is no underground mining and, happily therefore, no necessity for timber. All mining is in the nature of open cuts, or quarrying, the ore being taken out in benches, some as much as 100 feet high. In the view of the writer, benches of 50 feet, such as are employed in certain of the mines, represent the best practice as the presence of pockets of dirt in the ore makes it apt to fall, and therefore dangerous to work in high benches. The ore, although fissured and broken, is intensely hard and, after being turned over in large masses, must be blockholed and sledged.

After loading in mine cars the ore is never again handled. It is dumped into pockets, and from these lowered by gravity inclines to the main line of the railroad. Hopper dump-cars take it to the docks, where it is either dumped directly from ore car to vessel, or into storage pockets on the dock whence it runs by chutes into the hold.

The ore is mainly an amorphous hematite, with occurrences of specular ore and a quantity of magnetic oxide. It is of high quality, being rich in iron and low in phosphorus. Average analyses of 206,029 tons of Spanish-American iron ore show the following: iron, 63.1 per cent.; manganese, .097 per cent.; copper, .056 per cent.; sulphur, .072 per cent.; phosphorus, .029 per cent.; alumina, .712 per cent.; lime, 1.06 per cent.; magnesia, .381 per cent.; silica, 7.225 per cent.



THE LOLA MINE.

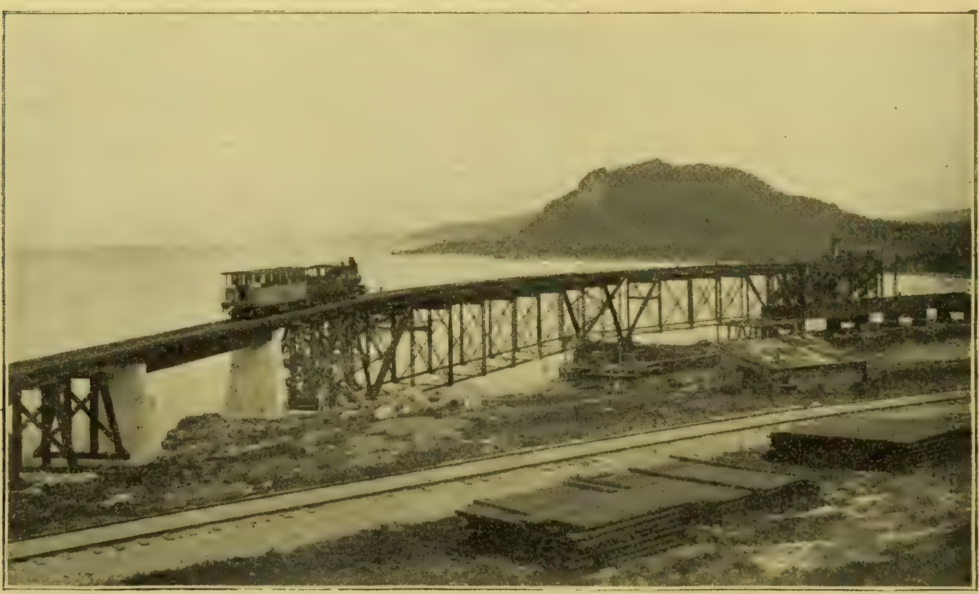
The light streak about midheight on the right-hand side is a stratum of dirt.

DAIQUIRI, FROM THE WATER.

Such, in brief, is the history of iron mining in the island of Cuba. What the future of the industry may be, it is difficult to say. It is notable that, although the two companies have continued in operation for several years, no new companies have started. The reasons are not far to seek. When the Juragua Iron Co. first began shipping, iron ore was worth $6.50, or more, per ton in the open market; to-day ore, even of the excellent quality shown in these analyses, will not bring half that amount. The present companies, with their capital invested in equipment, railroads, docks, and harbor improvements, must continue; but there is no temptation to capital to develop new mines. Any new opening necessitates a railroad, a dock, and harbor facilities; and there is nothing but a more than problematical profit on an unknown quantity of ore to invite to the investment. Moreover, there is another question, the most serious of all—the one of which the capitalist often fails to think on entering a new country, though he pays for this by thinking of nothing else after he enters—the question of labor. There has never been an adequate supply of labor since the mines were opened in Cuba. Tens of thousands of dollars have been spent to recruit the supply, and the cry is always for more. Once the Spanish government loaned soldiers for miners, and this was the brief golden era for the mines.

Since the war between the United States and Spain the question is even further from solution. One has not the whole labor world to draw on, because the northern laborer cannot stand the intense heat, succumbs to fever, and soon becomes useless. Even the Italian falls a victim to the fever. The native Cuban will not work in the mines if he can find anything to do in the fields and, as soon as the sugar estates start grinding, it is a foregone conclusion that the Cubans desert the mines for the fields.

The one man who can work in the Cuban iron mines is the Spaniard of Galicia, trained to this work in the mines of Spain. For him the heat has no terrors. He gets the fever and recovers and returns to his work. At his best he is sober, industrious, and saving; but his name is not legion and, since the war has driven him home, the lack of labor has become so serious as to menace the future of the whole iron industry in the island.



THE ORE DOCK AT DAIQUIRI IN COURSE OF CONSTRUCTION.

Much has been written from time to time of Cuba's wealth of iron. These points will possibly make clear why there has not been more development of this wealth. Setting aside the present uncertainty and lack of stable government, it is reasonable that capital should not seek investment where so much preliminary outlay must be made for railroad equipment, shipping arrangements, and the like, when ore is at a price which offers no inducements, when a 40-cent per ton duty rules against the ore, and when the very basis of all mining, "the tin-bucket brigade," is conspicuous by its absence.

AMERICA AND GERMANY AS EXPORT COMPETITORS AND CUSTOMERS.

By Louis J. Magee.

I.—NATIONAL RECOGNITION OF THE IMPORTANCE OF INDUSTRIAL EXPORTS.

DESPITE the watchword "America for the Americans" and a national tendency to adjust questions of import tariffs, commercial treaties, and territorial possessions independently of the ideas of other dwellers on the earth, every reader of THE ENGINEERING MAGAZINE at least must have been thinking with deep concern that the United States are not independent of other nations, and cannot afford to shape their policy without regard to its effect on their neighbors. To those who follow with anxious eyes the success of the great industrial army abroad, watching for the effect of the weapons of trade in the international struggle, the cry of "America for the Americans," with all that it means, sounds almost ironical. Those whose factory wheels would cease to turn but for foreign orders must surely feel that the United States have not for a long time past, commercially at least, been pursuing a policy of isolation. American capitalists and industrial organizers, agents, and experts who are using the influence of their country's representatives in foreign cities and employing every argument of technical excellence, giving every possible financial concession, straining every nerve to interest, please, convince, and gain the confidence of a new clientèle abroad, must sometimes wonder that their countrymen, as a people, can be so self-confident and indifferent to the friendship of other nations. Speaking of the international isolation of the United States, Richard Olney says: "The commercial isolation of a great power denotes its conviction that in matters of trade and commerce it is sufficient unto itself, and need ask nothing of the world beyond. In the case of the United States the policy of political seclusion has been intensified by a somewhat prevalent theory that we are a sort of chosen people; possessed of superior qualities, natural and acquired; rejoicing in superior institutions and superior ideals; and bound to be careful how we connect ourselves with other nations, lest we get contaminated and deteriorate.*

Coincident with the national self-examination which has been going on for some months, the critical weighing of world-interests, and the discussion of a future policy among nations, the question of America's place in the markets of the world, and in the great engineering enterprises, is also brought urgently to the front. But not only in the older markets has America suddenly found itself face to face with grave questions of trade. The probable opening of China to modern influences, and the achievement of the Trans-Siberian railroad, also cause one to ponder as to America's share in the development of these vast empires; and finally come the problems of organizing trade in territories where a preponderant influence has been recently acquired. "New issues and vastly larger fields of action have been opened. Three years ago we felt that our international issues—so far as they existed—had little relation to the great world's worry. To-day we are, for good or bad, in the midst of it all. Intercommunication and rapid transit have been steadily drawing the ends of the earth together. Silent mighty forces have long been assembling to the melting-pot the stubborn forms and patterns of the older world. Suddenly the fire is lighted." *

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* *Atlantic Monthly*, May, 1898.

The industrial elements in the United States know, in fact, perfectly well that they have fully emerged from anything like a policy of isolation, and that they are struggling with a new energy for opportunity to supply a good share of the world's mechanical necessities. It behooves the industrial elements, then, to work toward a broad recognition, on the part of the government, of the value, the very necessity, of export trade. They should make themselves felt, not in their demands for protection of the home market,—a protection which they no longer need,—but for the business-like regulation of foreign relations. Well-studied, comprehensive commercial treaties should be their aim, guaranteeing a certain term of unalterable trade relations, free from the caprice of domestic political parties, and protecting American and foreign exporters alike from the anxiety, the insecurity, that comes when great nations want to trade with each other and still cannot quite decide where to drop chicanery.

Bismarck said in the reichstag in 1885: "The most important element of our industries is manufacture for export. Let our export trade once become unable to compete with that of foreign countries, and our whole industry will suffer." The United States should recognize this as a government and as a people. The careful following up of the nation's interests in the detailed questions which directly affect exporters themselves is a *sine qua non*, if the central government is to seek advantages of its people's trade, open up new markets, or even keep exporters protected and uphold their efforts in those countries to which they have found their way alone.

The methods adopted by a great industrial nation like England, Germany, or America may not all be applicable to another country, but would certainly repay careful study—a study sure to engender mutual respect and appreciation among these mighty neighbors. At the same time that foreign nations appear to some branches of the industry in the light of competitors, they are to others perhaps only customers, and therein lies the short-sightedness of hard feeling and retaliation, and the reasonableness of a friendly and conciliatory attitude between the great industrial peoples. The study of trade questions should be distinctly separated from party politics, and should be in the hands of experts permanently in office. No great firm can work to advantage without trained heads, experienced organizers, and experts with detailed knowledge ; nor can a government support or protect its industries without an intimate acquaintance with their aims and difficulties. We have probably all thought, as we have wondered at the daily work of one of our great industrial leaders as he sits like a spider in his web where all the lines converge, that the country would be fortunate to have such business experience, system, and energy in that high place where the very qualities that make an industry great seem also to be so necessary.

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* Benj. Ide Wheeler, *Atlantic Monthly*, August, 1898.

Though not in the line of manufacturing industries, the case of the San José Scale is a good illustration of how a central government, by keeping itself informed, can protect vast commercial interests. Germany forbids the importation of all American nursery stock, or fresh fruit which is affected with living scale, protecting thereby its own horticultural interests from the disaster which has befallen the fruit growers of the United States. That the Agrarian influences at work in Germany caused the government to go too far in this matter, as well as in prohibitive measures against meat and cattle, is declared by liberal Germans to be the case, but this does not affect the value of the action in general. Germany was the first foreign government to obtain exact information on this subject, and her course has been followed by Canada, Austria, Holland, and other foreign countries. She had a scientist of ability at Washington, who kept himself as well posted as the department officials there. The United States might, with advantage, have made similar studies under diplomatic protection in foreign countries, for the majority of the principal American insect pests are of foreign origin.* The recent agricultural attaché at Berlin is of acknowledged high standing, and it was hoped that his position would be permanent. In general, however, the United States government seems to have little realization of the importance of having commercial or scientific experts to study conditions abroad. While the information gained by such experts would be largely confined to that which is publicly known in the countries where they are stationed and—through the press—open to the world, the relative importance of the methods and lines of development would be appreciated in a way that only personal contact can make possible. Just as misunderstandings of the gravest character come between business firms whose correspondence is most carefully attended to, and have to be adjusted by personal interviews, so the commercial relations of great industrial countries—enormous and complicated as they are bound to become in the future—will be much more fairly adjusted, if the statesmen have a large basis of expert advice to work upon. A thorough master of his own trade or industry stationed in a foreign centre of activity, reporting to a liberal-minded, well-informed superior at home, would, in all probability, be able to send information the value of which to the commonwealth would easily outweigh the expenses of a whole embassy. England and Germany set a most instructive example in this direction.

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* *Forum*, July, 1898, page 573.

The German consular service is being strengthened. Additional secretaries are to be appointed to several of the most important legations and embassies. Experts in agriculture and forestry are to be attached to the embassy in St. Petersburg. Commercial experts are proposed for service in the United States, South America, and Turkey. The London *Daily News*, in taking note of this activity, says: "It proves once more with what keen attention the German foreign office is watching and supporting German trade abroad. It is all done without fuss, and with the command of very poor means. . . . The German government, without neglecting agriculture at home, is making commercial interests more and more the basis of its foreign policy. German export trade forms the centre of gravity of almost every political transaction."

The German ministry of commerce, which has regulated the question of unfair methods of trade competition at home, has also cautioned German exporters against using methods or publishing statements in any way derogatory to articles of foreign make. Only recently the consuls have been especially requested to report regarding alleged statements deprecatory of certain English products. This certainly evinces a desire for fair play on the part of a government which does all it can to help its own people in their extension of trade. It is rather a high-minded policy, when one remembers how "Made in Germany" has been the watchword of an English crusade against German wares.

Another illustration of government aid to industries is to be seen in the reduced inland freight rate granted some years ago by German railways for articles *en route* to Spain. Of course, in the United States, such a reduction seems at present impossible, or exceedingly difficult to arrange. Apropos of this subject, a leader in the German financial world, when asked if he thought the United States government ought to control the railways, said: "A system which works well here (which indeed has given railways to poorer districts, where the traffic is too small to invite private capital) would not necessarily prove successful in other countries. In Germany our good organization is a natural consequence of our military system. A country like the United States, which is not accustomed to a similar strictness of organization and a well-ordered civil service comparatively independent of party politics and changes in the administration, may accomplish much greater things than we, but cannot without danger place its railways under government control."

It was a cause of great satisfaction when the emperor recently, on the occasion of his decennial celebration, created the representatives of three Prussian technical institutes members of the Prussian house of lords for life, "in recognition" (as William II said in a telegram which Professor Slaby—one of the three—read to his students after the daily lecture on electricity) "of the important place which engineering has assumed at the close of this century." The emperor has often attended Professor Slaby's lectures and watched experiments in the electrical laboratory. In general, the emperor's interest and appreciation is a permanent encouragement for men whose only ticket to court is brains. A retired captain and navy-yard director says that the emperor's observations on ship-building and armament show an astonishing grasp of the subject.

The government offices are easy of access. The officials, if sometimes afraid to take too much responsibility and overrun their competence, are always well informed in their special lines, appreciative of suggestions, and open to offers for improved methods, always ready to examine any means of helping German trade and follow up any alleged infringement on the privileges of Germans in the open market; and they are free from the suspicion of corruptibility.

The various departments of the government have on their lists officials who act only when called upon; professional men of all branches, teachers, manufacturers, and physicians, whose whole activity could not be paid for by the government, but who serve on committees or give written advice on the more important matters from time to time. For instance, the patent office puts important disputed cases into the hands of special committees, which sometimes include the highest obtainable authorities. In the State as well as the municipal service one continually comes upon this system of temporarily calling in experienced men, whom the government could not afford to monopolize, to give a portion of their wisdom for the public good. The unpaid officials of Berlin's city government make a list as large as the Berlin telephone directory. These men serve on the committees for almshouses, hospitals, parks, bathing establishments, etc., each giving gratuitously for the public good at least a deal of time, and frequently professional experience and expert knowledge. One of the medical authorities of Europe, a man whose clinic is a great favorite with American students, considers it an honor to serve on the committee of public baths for Berlin. The public performance of public duty, free of the acceptance of public money, is perhaps still more prevalent even in wealthy England. The marquis of Lorne referred to this characteristic of his country as "a case for free imports" into the United States. He quoted the late Lord Bramwell as saying at a public dinner, in reference to the work of a colleague, "he labored as only men do in this country (England) when they receive no pay."

In the extension of educational opportunities the German government is continually directing its attention to the intellectual betterment of the artisan and tradesman with regard to the promotion of foreign trade. There is great activity at present in the improvement of educational methods and facilities, especially in so far as they have a direct effect on industry. A new high school, for instance, for the teaching of "commercial science" has just been established by the government at Aix-la-Chapelle. This institute will be a valuable adjunct to the government technical institute in the same city. The plan of study includes a number of courses in various branches of economics and the commercial side of the industries. It is also proposed to increase and further develop commercial so-called continuation schools, and industrial schools for boys and girls. More complete workshops are to be established for learners, to replace or supplement the present system of apprenticeship. In connection with this reform, permanent exhibitions of first-class machinery and tools will be organized, as well as associations for workmen and shopkeepers.

In Berlin most varied opportunities are offered for systematic study of the trades and for the pursuit of common school branches in night schools especially established for wage-earners. The city maintains alone two school for artisans, where apprentices have instruction in drawing, decorative painting, mathematics, physics, chemistry, etc., including classes in the installation of electric plants, especially for wiring men. In these two schools there are more than three thousand students and more than one hundred teachers. Then the city has a school for masons, and one for carpenters and cabinet-makers. Furthermore, the city and State divide the expenses of another important school, -namely, a school for the training of workmen in architectural building; and, finally, a school for the textile industry. Ample opportunity is provided in most of these schools for the learning of English and French. Among other important industrial institutions in Berlin should be mentioned those founded by the guilds of most of the trades. Besides what the guilds contribute, the city and the State help to support these schools, the city providing in all cases the necessary room, light, and heat. From 10 to 50 per cent. of the cost of maintenance comes from the contributions of the students.

The "Urania" in Berlin, a people's physical laboratory connected with a "Scientific Theater" (where lectures illustrated by lantern slides and scientific apparatus are given), is an institution which out-yankeefies the Yankees for ingenuity. By paying twelve cents the poor student can go in and spend his evening in the laboratory, and perform each experiment in physics by simply "pressing the button." Germany is behind America in public libraries and reading rooms,—an advantage for which the United States has to thank private generosity rather than the commonwealth.

The technical high schools—*i. e.*, institutes of technology—are overcrowded. In the eight institutions of this class in Germany there are ten thousand students taking the courses or hearing some lectures, and of these fully one-half are studying mechanical, electrical, or marine engineering. Engineering societies have called the attention of the government to the need of more technical high schools, the desirability of making the conditions of entrance more severe, and the creation of technical middle schools to prepare students directly for the high schools. Probably American technical schools, in their methods as well as their equipment, compare favorably, to say the least, with those of Germany. Germany, however, deserves great credit for her pioneer work in technical education in the years when there was much less applied science to teach and much less national wealth to provide the schools and museums. Years ago, the present ambassador of the United States at Berlin, Andrew D. White, impressed by what he found in Germany, strongly advocated in America the introduction of veterinary, agricultural, and forestry schools, and thus the United States may be, for a good many of their splendid modern institutions, directly thankful for lessons taken (though but slowly) from Germany.

In connection with education, an interesting experience was recently related by the manager of one of the best known steamship companies. A large liner, bound homeward from South America with a heavy cargo and several hundred passengers, was laid up at one of the island ports of the west coast ot Africa by an extraordinary accident to the engine. A telegram came, demanding another steamer, as speedy repairs were impossible. After a lively interchange of messages, the home management was about to send out a reserve. At this juncture a German engineer of considerable theoretical knowledge, but without experience in marine engines, happening to be in the port, heard of the trouble, asked permission to examine the engine, and suggested a remedy, and the disabled ship proceeded homeward. The steamship company profited by this experience. It had learned that knowledge picked up in the practical experience of any one individual is insufficient to cope with all that may happen. It decided upon giving its engineers more theoretical training, and ordered a number off at half pay for two years' study. This course has become so popular that more men than it can spare from active service have applied for permission to study at half pay, although their full pay is low.

Naturally the same logical organization that is so praiseworthy in domestic affairs is bound to tell for the Germans in their efforts abroad. Their governmental methods deserve the deepest study on the part of a people like the Americans, possessed of unsurpassed courage, shrewdness, energy, and intense practicalness, combined with a love of liberty which sometimes amounts almost to disorder.

THE TALL BUILDING UNDER TEST OF FIRE.

By H. de B. Parsons.

THE modern "sky-scraper" presents many problems, but none more generally interesting than the question of its security against fire. The picture below shows the result of the careless dropping of a lighted match. The photograph presents the ruins of the Burdette Block, in Troy, N. Y., which was wrecked by fire on February 17, 1896. The building was erected in the ordinary manner, with brick walls and wooden floors. So rapidly was it consumed that four lives were lost, although the fire took place in the day-time. Buildings of this class are totally unable to resist fire.

Many imagine that, because iron and steel are incombustible (in the common acceptation of the word), buildings constructed of such material, together with bricks, cement, and glass, may be classified as fire-proof. The construction of a building out of materials in themselves non-combustible does not produce a fire-proof structure. Fig. 2 represents the ruin of the Quinsigamond mill, Worcester, Mass., caused by fire on April 5, 1896. This building was erected on the independent plan, a steel frame supporting the floors and

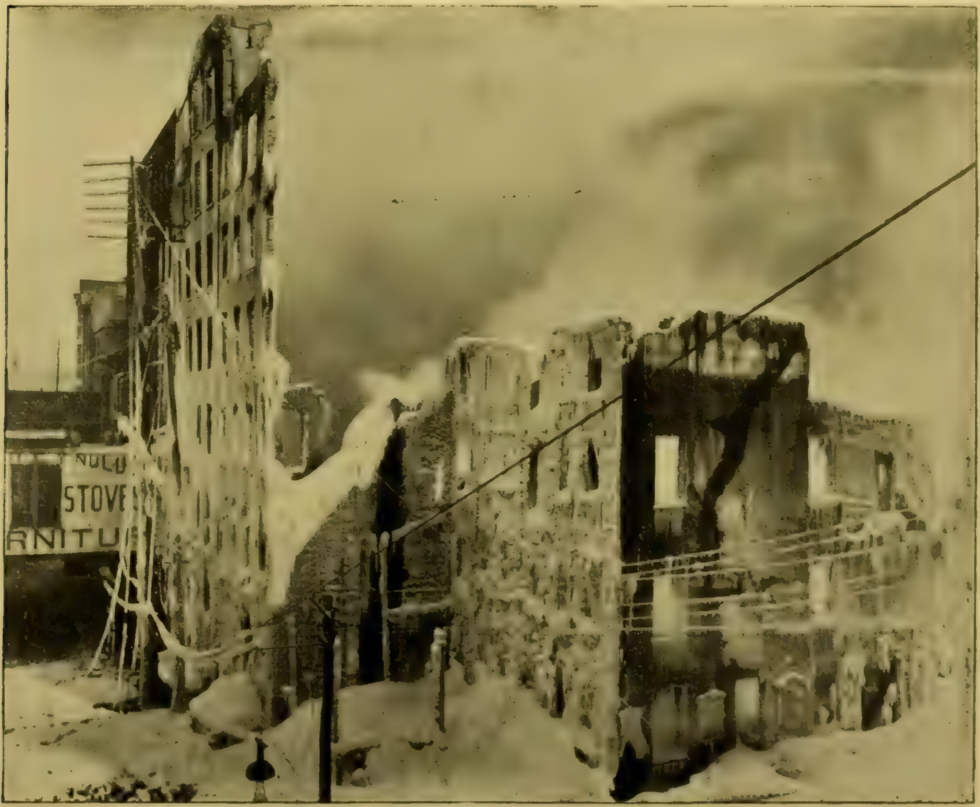


FIG. I. RESULTS OF A FIRE IN TROY, N. Y.

roof. The columns were of built-up steel, carrying floor-beams of the same material. The window-boxes were of steel, and the walls were of brick built in between the frames so as to enclose the whole. Wood was used for the flooring on the "slow-burning" plan. The photograph very clearly shows the result; how could the destruction have been more complete? The building was entirely gutted, and the columns and beams were twisted into an entangled mass. Witnesses of this fire state that the columns began to yield from fifteen to twenty-five minutes after the fire started, although the floors were not heavily loaded. Had this building been erected on the "slow-burning" principle, it would have resisted the fire much longer. In this type of construction heavy wooden columns and girders are used, which retain for a considerable time, when subjected to fire, sufficient strength to carry their super-imposed loads, permitting the escape of the occupants, the saving of valuables, and the arrival of assistance. Such examples show that plans for all buildings in crowded districts should be intrusted only to the best of designers.

The design would be much simplified if there were no fear of fire. What constitutes a "fire-proof" structure? The term "fire-proof" has become generic, and is in many instances a misnomer. In its usual sense it is used to designate a certain style of modern structure that has become very popular. Structures of this type rely, for their stability, support, and fire-resisting properties, on the steel and iron skeleton frame and on the other non-combustible materials used.

It has been repeatedly proven that metal construction cannot withstand fire, unless well guarded. No matter how "fire-proof" a

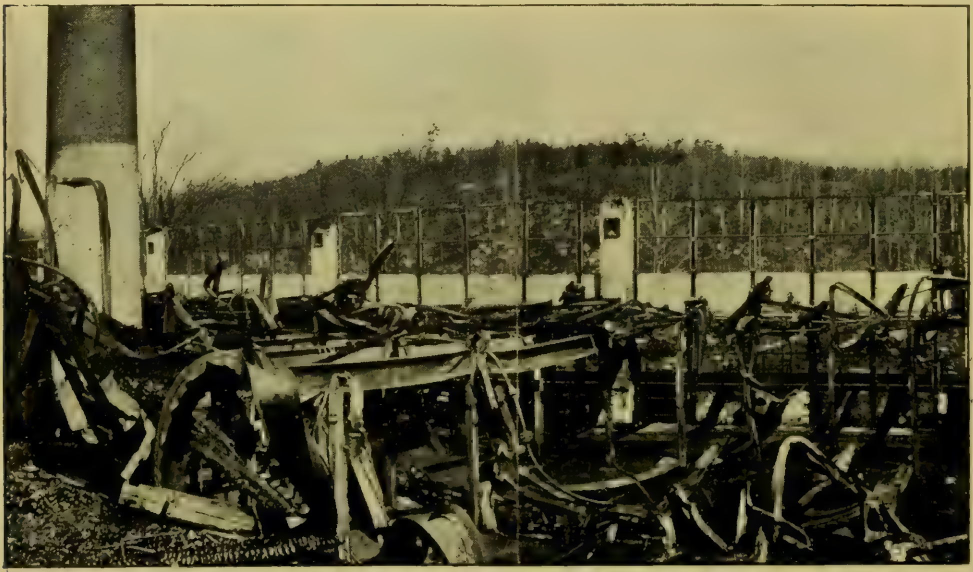


FIG. 2. RUINS OF QUINSIGAMOND MILL, WORCESTER, MASS.

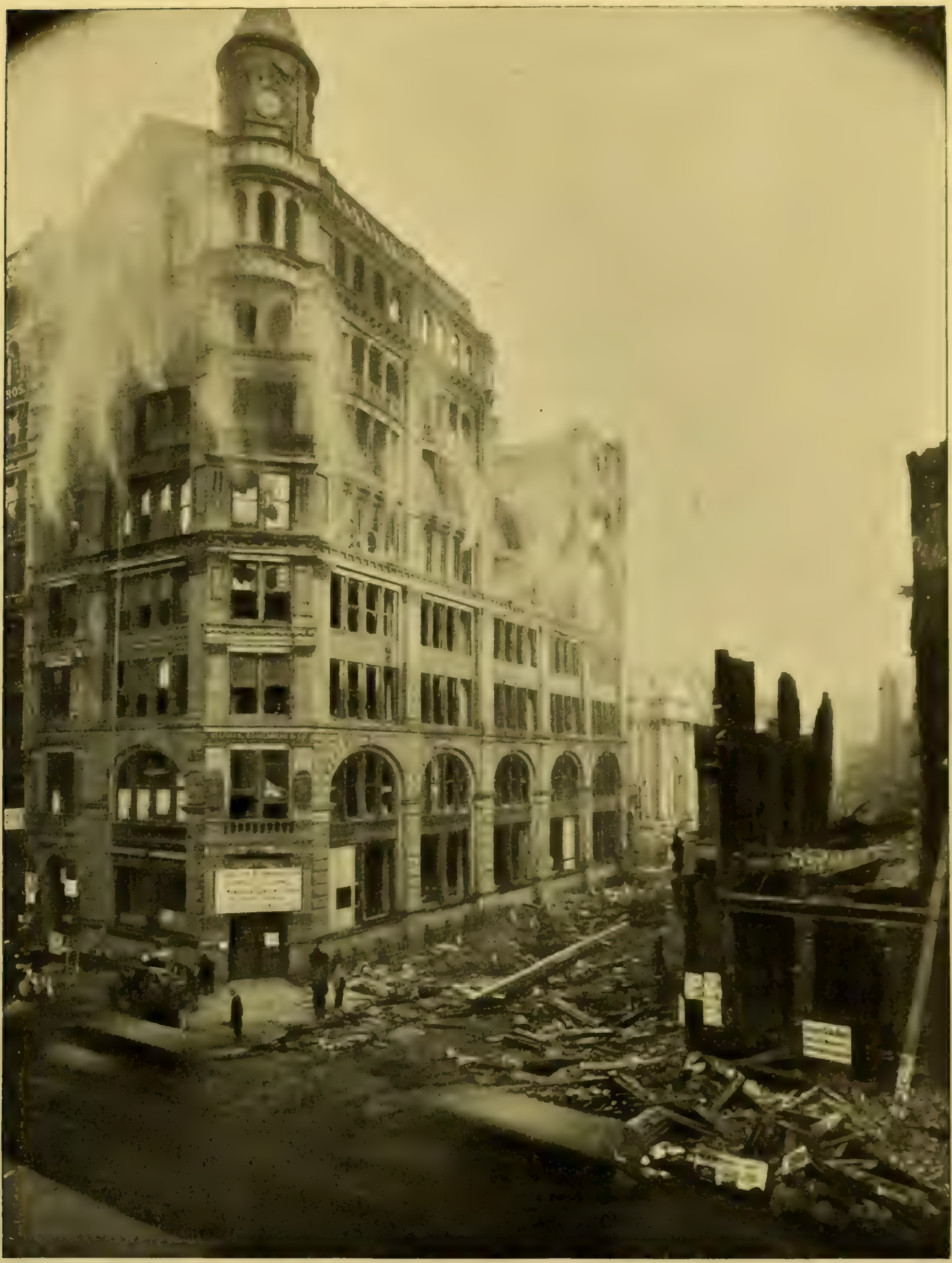


FIG. 3. A FIRE-PROOF BUILDING WRECKED BY A FIRE ACROSS THE STREET.

building may be, it will be ruined, if sufficient combustible material is stored within to create a hot fire lasting for a considerable time.

Manufacturers have produced many forms of fire-proofing protection, and have striven to obtain something that will not burn. Architects and engineers have given too much attention to the substance of which the fire-proofing has been made, and not enough to its proper application. It is, however, fortunate that the present tendency is in the direction of protecting the metal skeleton as a primary object, since upon it the self-sustaining properties of the whole structure depend. It should be a secondary object to so subdivide the floors as to confine the fire.

Without injuring the usefulness or the efficiency of the building, the amount of combustible material now used could, by careful planning, be reduced. In the ordinary American office building wood-work is commonly used to a much larger extent than generally supposed. Taking as an instance a ten-story building of recent fireproof construction, the wood-work in the floors, panels, bases, chair-rails, doors, window frames, and general trim amounted to about two pounds for each cubic foot of contents. This estimate did not include the furniture or movable office-fittings. The total weight of wood was about 1,200,000 pounds, or as much as the weight of the iron frame. In some of the largest and newest buildings the weight of wood-work has been reduced, but there are many in the sky-scraping class in which the wood considerably exceeds the weight of metal.

A number of these tall structures are more vulnerable from fire without than from fire within. The design is often such as to render it difficult for a fire to obtain headway within the building before its discovery, while the same building would be most susceptible to damage if a fire should occur in the immediate vicinity. Designers fail, as a rule, to give due weight to the value of these external hazards. A good example of this is seen in Fig. 3, a photograph of the damage done to the Manhattan Savings Institution Building through a fire on the opposite side of the street. The girders in this building were unprotected, and, failing, permitted the floors to fall.

Some three years ago a joint committee, representing the insurance, architectural, and engineering interests, made some elaborate tests of the effect of fire on full-sized metal columns, finding that such columns failed when heated to a faint red color, representing a temperature of about 1,200 degrees F. The steel columns buckled at the centre, while the cast-iron ones bent, snapping, if not relieved of their load, when the amount of deflection began to exceed the diameter. The time required to cause destruction varied from 29 minutes to 2 hours, according to the character of the test,—a result which agrees very closely with the failure in the Worcester mill. The cast-iron columns were heated to more than 1,100 degrees F., and were then suddenly cooled by means of a fire stream. No injurious effect was produced, beyond the cracking of the furnace brick-work.

The result of our knowledge, based on actual experience and on experiment, is that iron and steel cannot support a load when heated

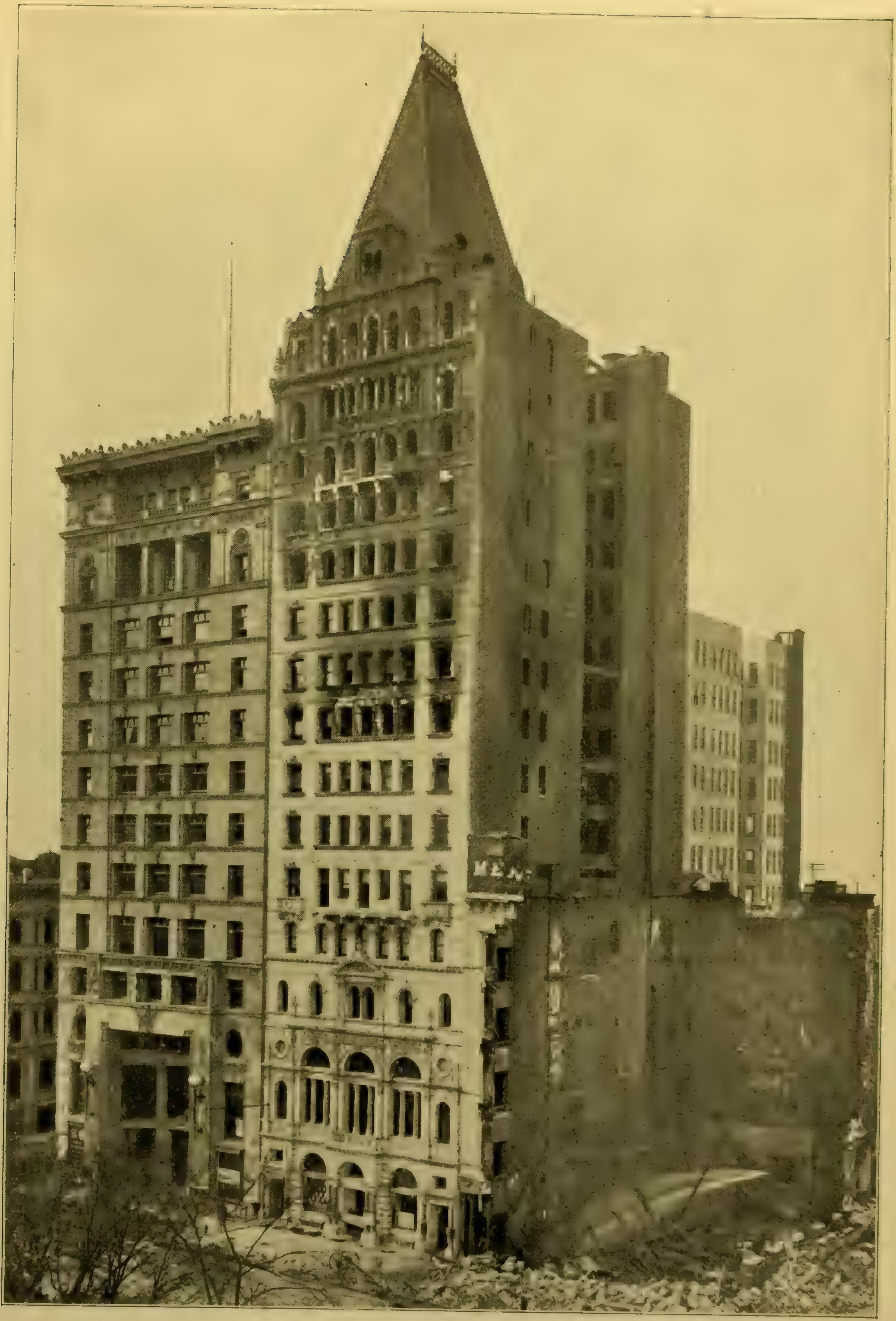


FIG 4. THE HOME LIFE BUILDING, NEW YORK, AFTER THE FIRE.

to a faint red. The metal must be protected. It will not suffice to have simply a non-combustible protecting material; the material must be of such a character that it can not be disintegrated or dislodged either by water or by expansion. The covering must be so fastened as to remain in place, and such fastening is best accomplished by self-bonding, and not by wiring or similar artificial means. The desire of the owner and real-estate agent to obtain light for halls at the expense of safety, and to economize space by placing the stairs and elevators in the same well, should be strongly restrained.

It has become possible to consider from a practical standpoint this important subject of a fire-proof building versus fire, by taking as an illustration a recent conflagration in New York city. The building in this instance was no doubt much favored in the assistance rendered by one of the most efficient fire departments in the country. On the night of December 4, 1898, a fire occurred in a five story ordinary brick and wood building, situated on the south-west corner of Broadway and Warren street, occupied by Rogers, Peet & Co., as a retail clothing store. Adjacent to this, on Warren street, was another, but smaller, building of similar design, used as an annex. On the south was the comparatively new Home Life Insurance Building, and, next to it, that of the Postal Telegraph Company.

The general appearance of the Home Life Building is shown in Fig. 4, on the preceding page. It has sixteen stories, and the floor plan is arranged with a light shaft in the middle of the north side. Along this light shaft are the elevators, and next to them is the staircase. The side and rear walls are of brick, while the front is of marble, built solid from the foundations. The building, with the exception of the front wall, is constructed on a skeleton framework of steel. The walls are lined with 2-inch porous terra-cotta furring. The floor arches consist of 12-inch and 9-inch hollow, hard-burned, terra-cotta blocks, the skew-backs covering, with their soffit extensions, the lower flanges of the steel floor beams. The columns are of steel, built up, H sections, and covered with 2-inch porous terra-cotta furring blocks. The girders are protected on their sides with the same terra-cotta blocks, while their soffits are covered with wire lath and plaster. The upper chords of all the girders, except one on the sixteenth floor, are buried in the floors. The principal partitions are made of 4-inch porous terra-cotta blocks without metal supports. Many of these partitions are not continuous to the ceiling, being finished off with large plain glass transoms set in wood framing. All the windows were of glass set in wood sashes and window boxes. There are no shutters. The finish of the office-floors consists of a wooden floor laid on sleepers placed across the floor beams, and not buried in ashes or cement. The walls and ceilings are plastered. There is a varnished base, chair-rail, window-, door-, and transom-trim.

Within an hour after the fire started, a strong northerly to north-easterly gale was driving the flames from the Rogers-Peet building against the walls of the Home Life Building and into the light well, which acted as a chimney. The fire entered the unprotected windows of the eight upper floors, and found inside a natural draft through the elevator openings. The result was the total destruction of the contents of the upper eight floors, and the saving of the Postal Building by its equally tall neighbor. As a fire stop, the Home Life Building certainly succeeded admirably, for, had it not been there, it is fearful to contemplate what might have resulted during a gale of almost hurricane force. Such buildings are not, however, erected or designed as fire stops, and can be so treated only incidentally.

The vagaries of the flames were as peculiar as ever. In one room where the contents were destroyed a waste-paper basket remained, and in another a towel still hung on a rack unscorched, although the room was totally wrecked. The lower eight stories escaped the fire, but suffered from water.

In the accompanying pictures can be seen the total destruction of the finish of the various floors, nothing being left except the absolute fire-proof material. The plaster work, although not combustible, was absolutely destroyed, and in all of the rooms, from the ninth floor up, there is hardly any plaster left on the walls. The wire lathing used over the pipe chases in the walls and over the various irregularities in the building appears not to have stood the attack of the flames. This may have been due partly to the manner in which it was fastened, but more probably to the fact that the metal expanded sufficiently to throw off the plastering, which has no flexibility. The wood-work used in the finish of the building was not preserved in any of the rooms reached by the fire, except in a few in the rear of the building. In some of these a part of the office furniture still remained, although badly wrecked. In one room on the fifteenth floor a tall wall book-case still stood. The book-shelves were protected by the closely-fitting books placed upon them, while the books were damaged beyond use. Had these shelves, however, been in the front of the building, they, no doubt, would have been destroyed, as there the fire appears to have been fiercest, probably because there were window-openings on the north wall of the east wing. Those partitions which were cut for the purpose of inserting large transom windows near the ceiling suffered most. The glass in these windows no doubt broke, and permitted the flames to spread from room to room, thus removing the value of these partitions as fire stops.

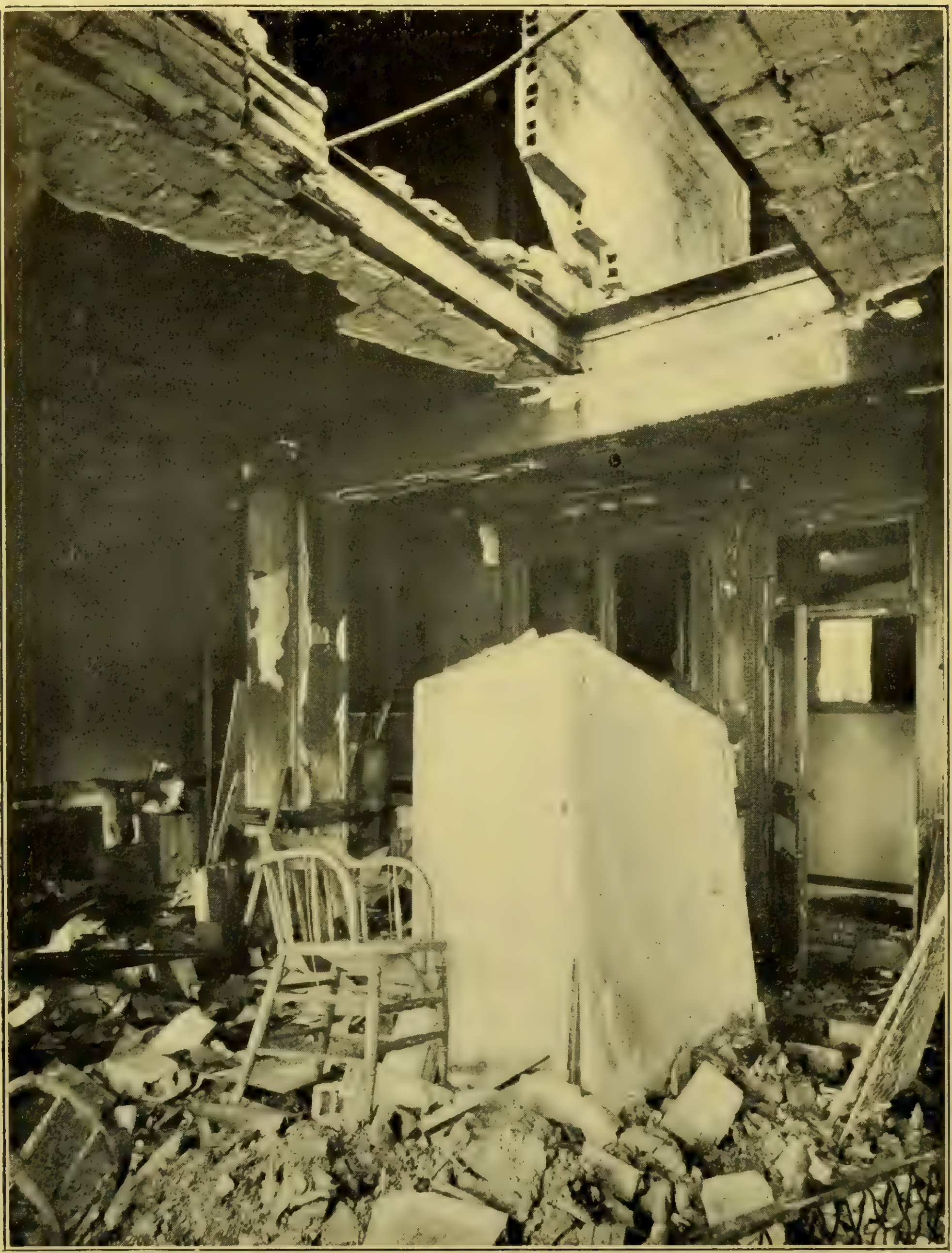


FIG. 5. HOME LIFE BUILDING, 9TH FLOOR—THE LOWEST DAMAGED BY FIRE. The large safe fell from the floor above.

The accompanying illustrations—Figs. 5 to 10 inclusive—convey a clear idea of the ruin accomplished. The main metallic framework was but slightly damaged. A large proportion of the injury seen in the photographs was done by the firemen and the building inspectors, and cannot be attributed to the flames. In Fig. 5 is seen a large safe, weighing about 4,000 pounds, which fell from the floor above into a room on the ninth floor, lately occupied by the Rapid

Transit Commission. It is reported that the firemen cut a hole in the arch for the passage of a hose, and thus permitted it to fall. Whether this statement be true or not, the ninth floor was sufficiently strong to retain it. The photograph shows the floor beams uninjured.

Fig. 6 shows a view of a room in the front of the building, on the tenth floor. The ceilings and partitions are intact, but the plaster and wood-work were totally destroyed.

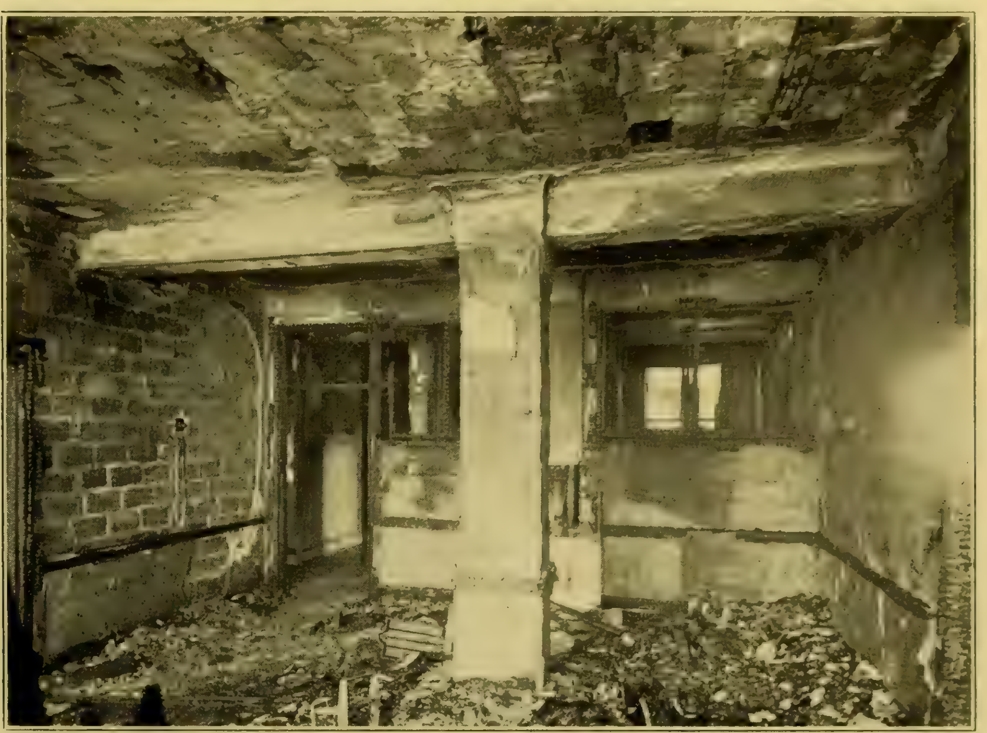


FIG. 6. 10TH FLOOR. COLUMN AND GIRDER COVERINGS AND PARTITIONS INTACT. Transom windows seen in partition.

The destruction of the wooden flooring throughout the upper stories was largely due to the considerable air-space between the wood and the flat floor arches. This space should not have existed ; had it been filled, the floors would have stood much longer.

The effect of using other material than wood for flooring is plainly illustrated in the various halls, which were subjected to an enormous heat. The flooring of the halls was made of mosaic blocks. These blocks retained their position, and the floors were practically uninjured, although there is nothing left of the wood flooring in the rooms adjacent. The amount of wood used was no doubt excessive, viewed from the standpoint of best practice. The photographs show that wood-work will not stand a hot fire, even when embedded in the walls. Other material can be adopted for chair-rails, bases, and panellings without injuring the appearance or the utility of a building.

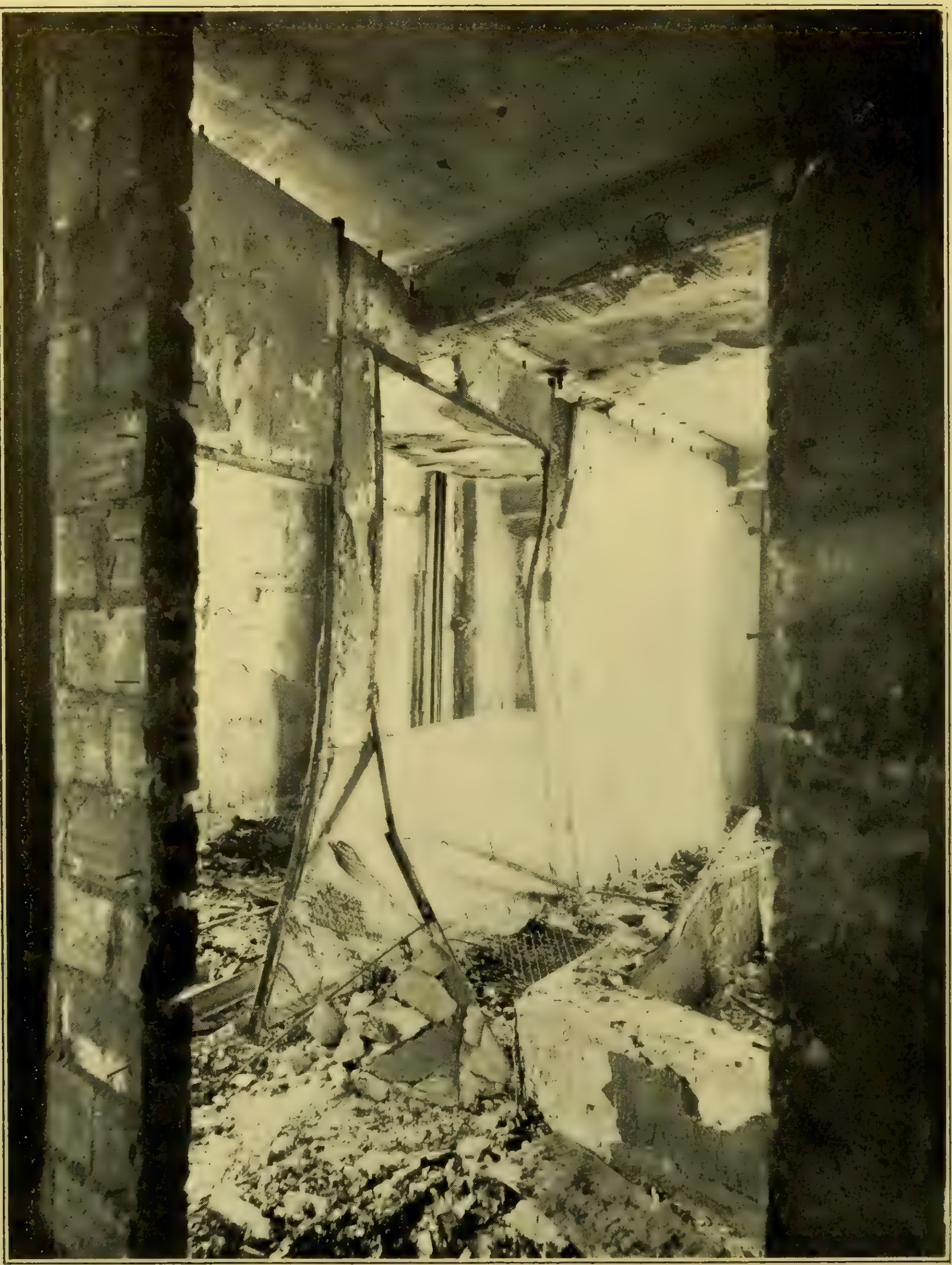


FIG. 7. 12TH FLOOR, FRONT, SHOWING AN EXPANDED METAL PARTITION.

Fig. 7 shows an expanded metal partition in bad condition in a room on the twelfth floor. Some of these expanded partitions were built directly on the flooring, and their failure was caused principally by the burning of the wood, depriving them of their natural support.

Fig. 8 is a view on the thirteenth floor, showing a column with a portion of the fire-proof blocks removed in order to make an examination of its condition. As is clearly seen in the photograph, the column was uninjured and still covered with paint, although the heat in the room was sufficient to destroy the expanded metal and plaster covering the pipes placed against the rear column. The ceiling in this room and the partition of terra-cotta remain intact, although all the wood-work was totally consumed.

Another column is shown in Fig. 9, which is a photograph of a room in the front of the building on the fourteenth floor. The covering had been removed from this column for the purpose of examination. This picture shows the plaster-work completely destroyed, although the partitions and ceiling blocks remain intact. The floor

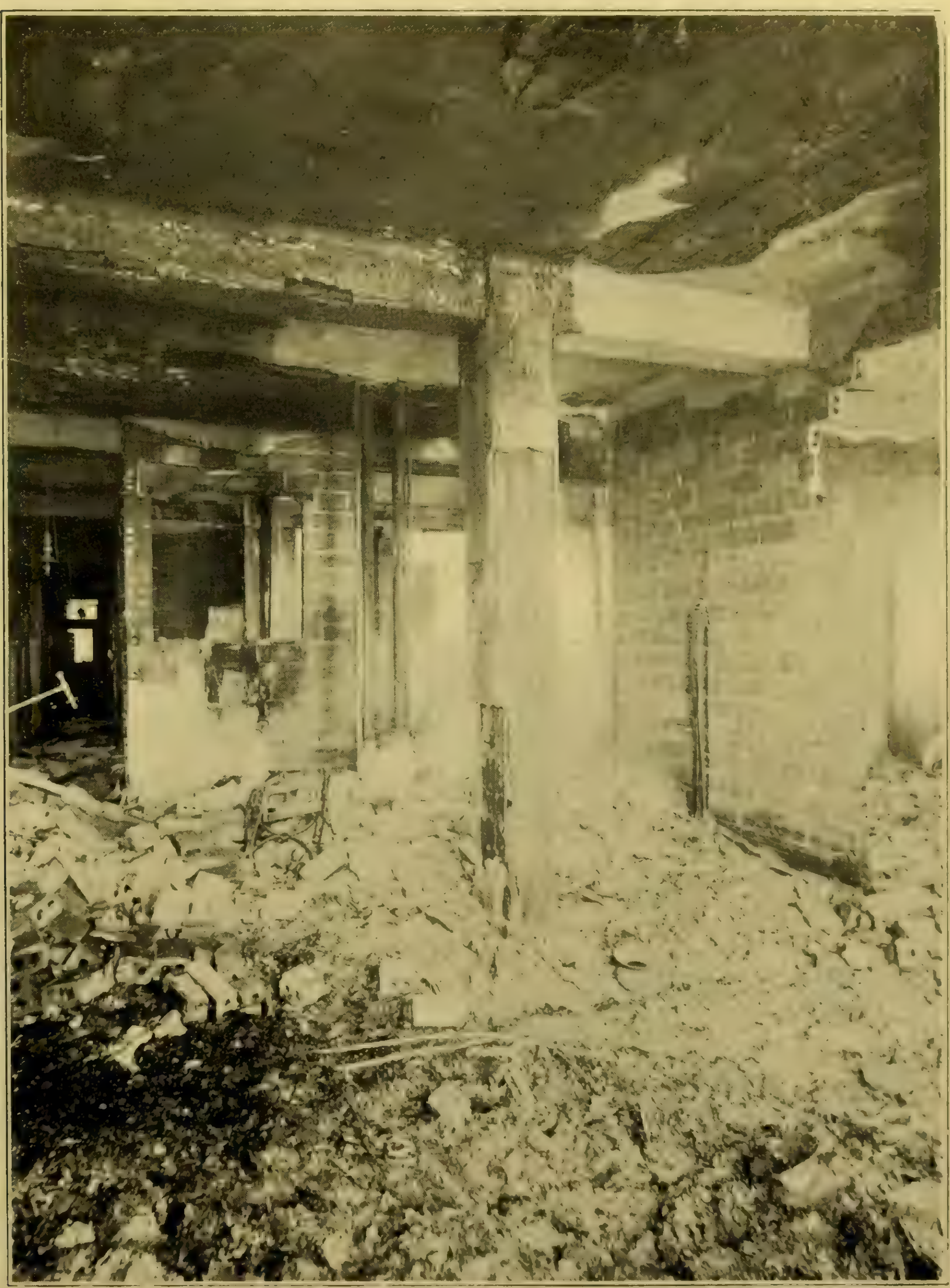


FIG. 8. 13TH FLOOR. THE COLUMN AND GIRDER ARE UNINJURED.

arches also remain unbroken, although the safe shown in the picture fell over on its face, on account of the destruction of the wooden flooring upon which it rested. The partition shown in this picture was torn away by the firemen, in order to facilitate their work.

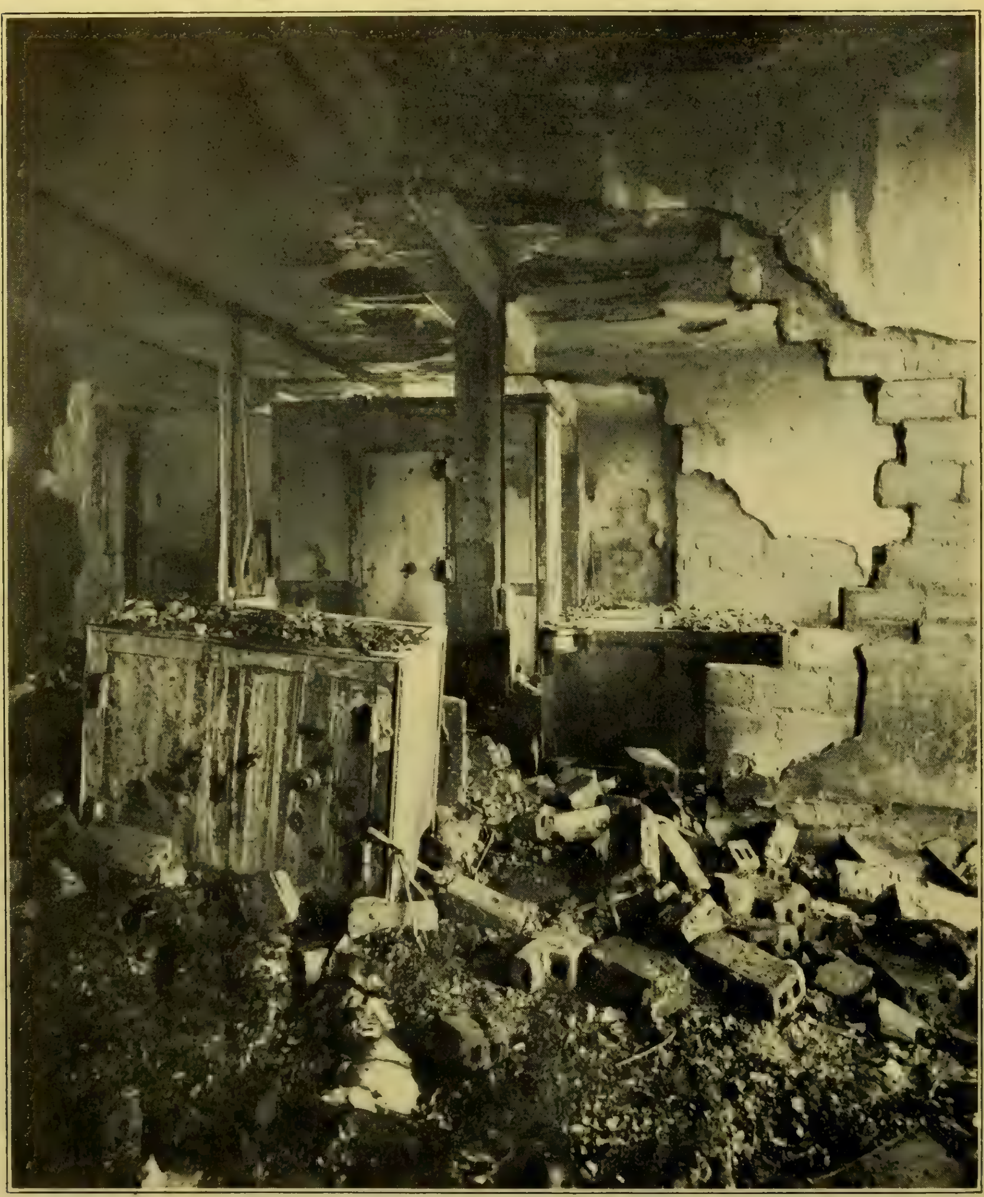


FIG. 9. 14TH FLOOR, FRONT. SHOWS GENERAL DESTRUCTION OF CONTENTS.

Fig. 10 is a photograph taken on the sixteenth floor in a front room of the building. The column remained uninjured, as is shown by the subsequent removal of the terra-cotta blocks. The partitions of terra-cotta on this floor remain intact, although the plastering was completely destroyed. The distorted girder probably represents the greatest damage done to any one member of the metallic frame. This was one of the main girders of the building, and was protected on the soffit by terra-cotta blocks and wire lath. It differed, however, from the other girders in having its upper chord project above the floor.

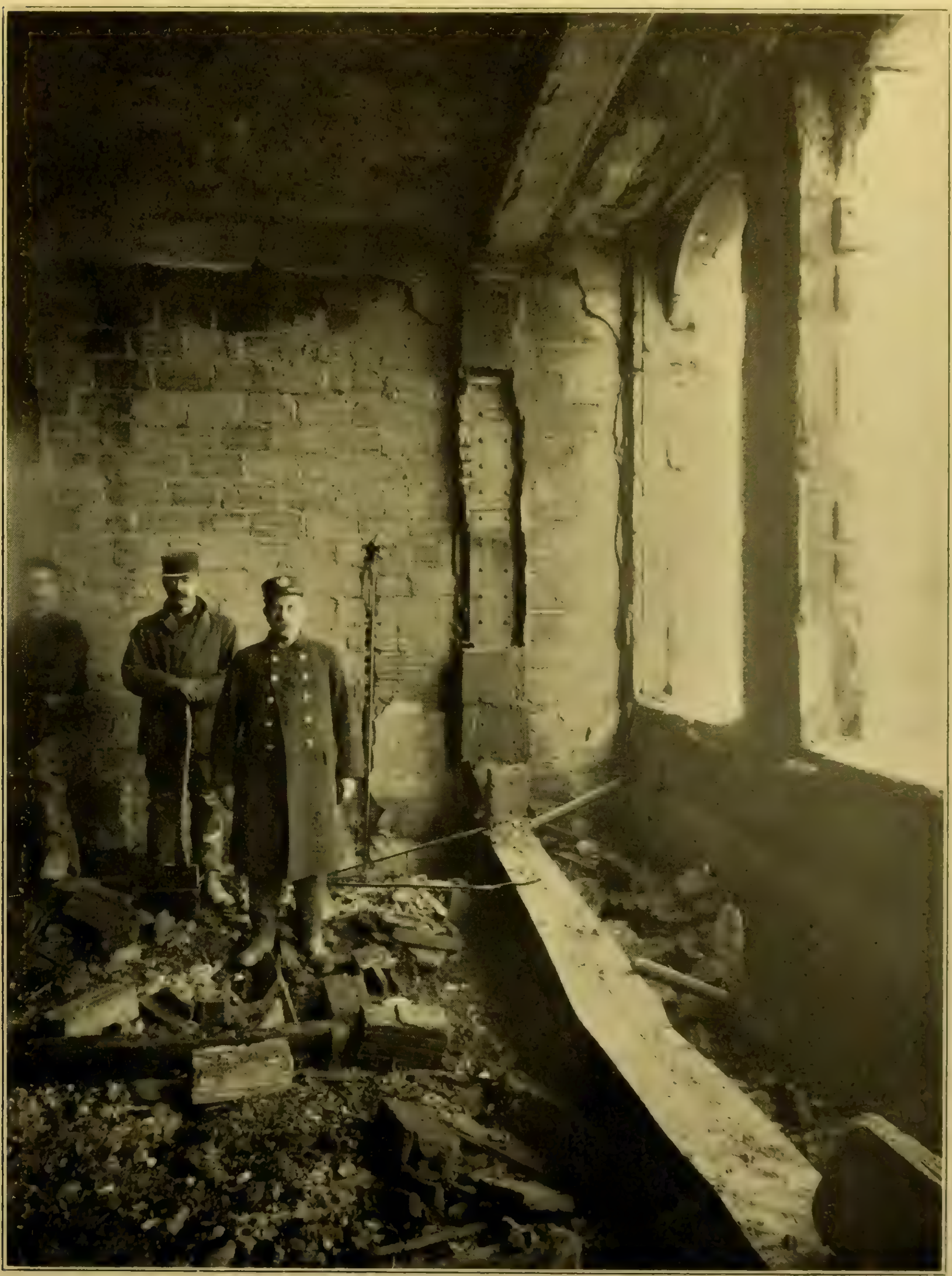


FIG. 10. 16TH FLOOR. A DISTORTED GIRDER IN THE FRONT OF THE BUILDING.

The part projecting was not protected by fire-proofing material, but was boxed in with wood, forming an elevation in the floor-space of these rooms. This wood-work, of course, was completely destroyed, leaving the metal exposed to the fire. No doubt this portion of the girder became heated, and buckled on account of being in compression. Had the exposed part been in tension, it doubtless would have retained its shape, as there is no evidence to show that the heat was sufficient to have injured it under such conditions.

The fire had no difficulty in entering the building, as all the windows on the north side were unprotected. The building might have been saved, had these windows been equipped with iron shutters, and had wired glass been used in a metallic frame. This wired glass will resist an immense amount of heat, and, although it breaks in time, the pieces remain in place. Metal frames fitted with wired glass could have been used to advantage in all the partition transoms. Such an arrangement would have given nearly as much light throughout the building, and would have been a better fire stop.

The flames, on entering the elevator shaft, appear to have gone at once to the sixteenth floor, as the destruction of the trellis work and iron framing around the elevator doors is greatest at that point. Owing to its position, the staircase was rendered useless as soon as the fire obtained considerable headway, although, as constructed, it was partially protected by the division wall between it and the elevator shaft. The stairs remained intact, so that they could be used as soon as the fire was extinguished.

The front of the building was built of solid marble, the poorer pieces obtained from the quarry being used as backing. The façade was relieved with balconies and other ornamentations, and a row of columns supporting arches made a finish to the fifteenth and sixteenth floors. The fire totally wrecked the marble, wherever it was exposed.

Marble and granite have but little fire resisting power, and it seems useless to adopt them in a building intended to be fire proof. They are so susceptible to heat as to be liable to injury by fires occurring at a considerable distance. A greater heat than that to which the marble was exposed was endured by the brick-work on the north face, and by the brick-work up the light well. The chief visible damage to this was the cracks caused by the expansion and contraction of the braces reaching across the light well and stiffening the two wings.

Taken as a whole, the building resisted the action of fire remarkably well. Within a week many of the offices on the lower floors were again in use. The steel structure, with the exception of a few portions, such as the girder mentioned above, can remain without repairs. The damage to the floors was slight; and, although the total wreck was great, it was practically limited to the trim and contents of the various rooms on the upper nine floors. The front wall, however, was ruined from the eighth story up. No doubt the destruction would have been less, had as much care and energy been bestowed upon the details of construction and finish as were given to the main frame-work and general plan.

The building contained its own fire apparatus, but it is reported that this failed early in the evening. Owing to the height of the building, it was impossible for the fire department to reach the seat of the conflagration. The fire, therefore, had great liberty, although it was effectually prevented from spreading to the lower floors.

Here was a building which was, in the ordinary sense, a fire-proof structure, and yet it was damaged. Again arises the question: "What constitutes a fire-proof building?" It is evident that, if fire is brought into contact with articles that are combustible, those articles will be burned; and that, if the fire must be confined to one specific space, that space must be enclosed effectually by absolutely fire-resisting material, which must be so constructed as to form practically a furnace. Such construction is not applicable to a building used for ordinary purposes. The next step, then, is to so arrange the structure that, when fire takes place, no damage shall be done to the main members, whether those members be of masonry, iron, or steel.

In all our cage constructions the members needing the greatest protection are the columns, girders, and beams. It is not difficult to protect these members effectually, provided the owner and the designer are willing not only to spend the proper amount of money and care, but to give up the requisite floor-space. This part of the problem was fully illustrated in the Home Life Building, as the only members seriously injured were the unprotected parts of the metal structure. It is axiomatic to state that floors should be separated from each other, so as to confine the flames. This is a condition difficult to attain, as perforations must be made for both stairs and elevators. These openings are generally placed so as to take a minimum of floor-space, and thus render a maximum area available for income-earning purposes. Nearly every intending builder examines the various buildings, estimates the amount of space devoted to public use, and concludes that the best building is the one that has given up the least percentage of space. While this effort is commendable from the purely income earning standpoint, it not only has the effect of rendering the design dangerous to life and property, but makes it almost an impossibility to so design a building that it shall be fire-proof.

In any building there must be, and always will be, an amount of combustible matter that cannot well be reduced. It is, therefore, essential that the least amount of combustible material shall be used in construction. In those rooms in the Home Life Building which suffered the least damage, it was clearly shown that the combustible materials placed near the ceiling were destroyed more rapidly and more

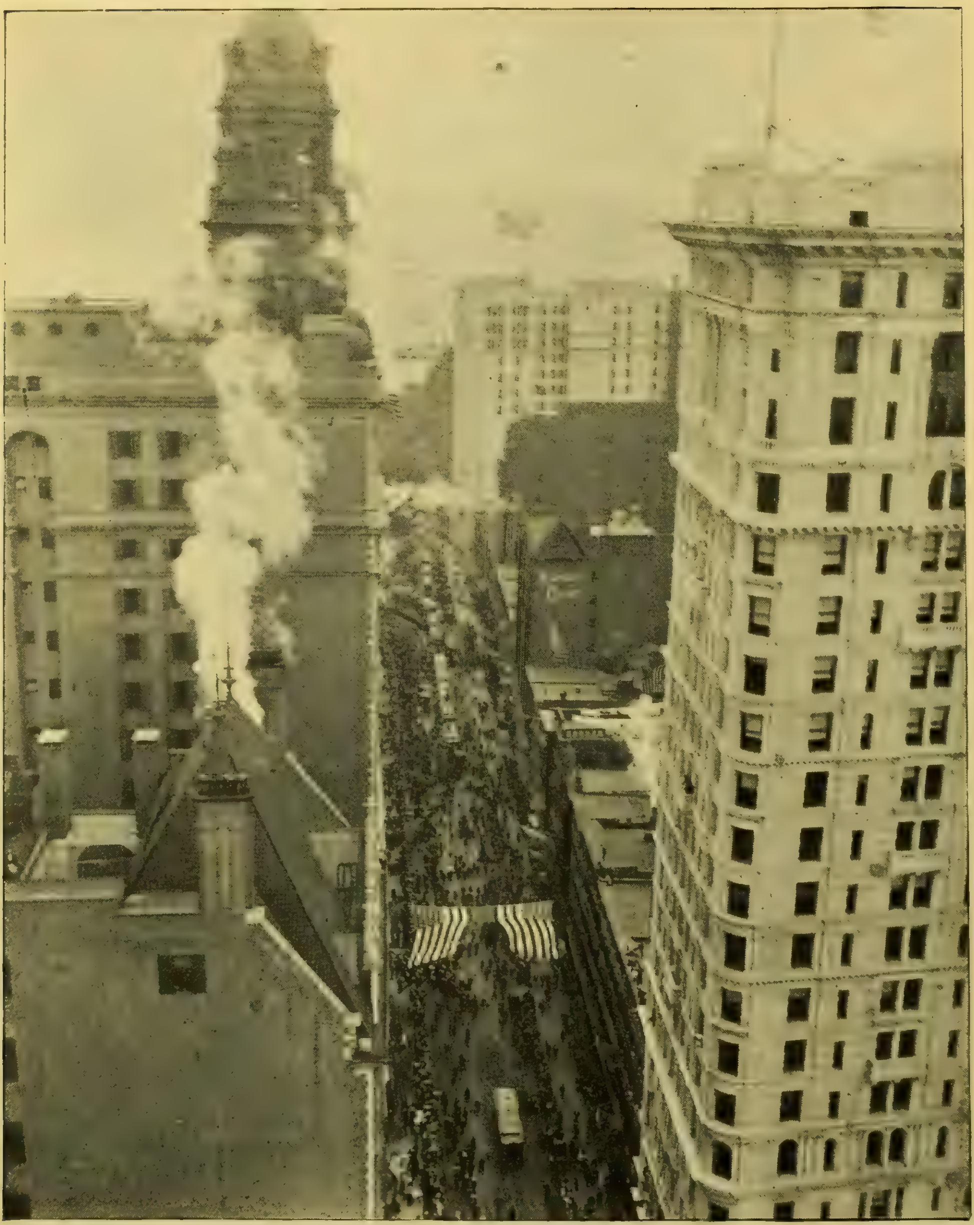


FIG. 10. SUGGESTIVE OF THE DIFFICULTY OF REACHING THE UPPER STORIES OF A SKY SCRAPER WITH A FIRE STREAM.

completely than those nearer the floor. The heat and flames naturally follow the ceiling, and the ordinary fire-proof partitions in which there are large transom windows are thus rendered useless as fire stops. The use of transoms in these partitions is no doubt a necessity, but they should not be fitted with material so friable as ordinary glass.

Even in a fire-proof building dependence must be had upon human aid. When the building is tall, it towers beyond the reach of the fire department, and reliance must be placed upon other means.

A fire in the lower stories is easily accessible; the conditions to be most dreaded are those of a fire in the upper stories. The difficulty can be inferred from Fig. 10, which is a view of Broadway, N. Y., from one of the upper floors of the American Surety building. Many modern tall buildings are designed with their own pumping plant to supply a roof tank for fire and other purposes, and are equipped with a large stand pipe from six to eight inches in diameter, which is siamesed on every floor for hose connections. This stand pipe is also arranged with a check valve and with siamesed branches at the foot, so that fire engines can be attached, in case of the disability of the self-contained plant. It is well so to arrange the stand pipe that the engines can also operate in conjunction with pumps in the building.

In many cities which maintain a system of fire boats there are laid underground pipe lines of large diameter. As these fire boats are equipped with pumping apparatus far exceeding the power of the largest land engines, they are able to force water under heavy pressures to long distances, provided the mains are made of sufficient area to minimize the friction losses. This system, operated in connection with the building stand pipe, would materially assist the firemen.

The question naturally arises whether it pays the owner to make a building thoroughly fire-proof. Unfortunately there are many who build for the specific object of obtaining the greatest income from a minimum outlay, and the effort to save on the first cost is so great as to render their judgment valueless as to what should or should not be done. Tall buildings of cheap construction are a menace not only to the owner and tenants, but to the community. Too much stress cannot be laid upon the great aid that could be rendered, but unfortunately is not, by the insurance companies. If they would be more strict in the classification of their risks, improvement would immediately follow.

Are these tall buildings really good investments? The increase in height appreciates the value of the land, but how much of this appreciation is offset by the depreciation of the building, by the extra cost of maintenance, insurance, repairs, taxes, interest, etc.? In other words, would not a smaller building pay a greater percentage upon the money invested, if a careful and accurate balance-sheet should be drawn up? Following the same line of thought, there has arisen the question whether the height of buildings should not be limited by law? If every building could be constructed upon utopian principles, probably there would be no reason to limit the height other than one of a purely æsthetic character. As such a state of affairs does not, and probably never will, exist, and as so-called fire-proof buildings are liable to be constructed, it seems that some form of proper restriction would be advantageous to the community.

FAST RUNS ON THE NORTHERN RAILWAY OF FRANCE.

By Charles Rous-Marten.

DURING four recent visits to France it has been my privilege to make many observations of the locomotive work on the Northern Railway of France. I may at once say frankly that the results obtained completely eclipse any that have come under my notice in the course of my many years' experience of British railways.

If I do not make comparisons with American work, it is because my American experiences have yet to come, and I do not, as a rule, deal with any performances that I have not myself personally recorded. My only exceptions consist of cases which are authenticated beyond reasonable doubt. Pending, therefore, the personal observations of railway work in the United States which I hope to be able to make at no distant period, I limit my comparisons to France and Great Britain exclusively.

Few things are more surprising in railway history than the progress which has been made by the Chemin de Fer du Nord to the high place—virtually the first place—which it now holds among European railways. Of all the continental lines it now is *facile princeps.* There is no other railway on the continent which approaches it in smartness. Even in England it has no rival in start-to stop speed. The Great Northern approaches it most closely, with two runs timed at 55.3 miles an hour, while the Great Central has a short distance booked at 55. But against these the Chemin de Fer du Nord has one booked at 57.7 and one at 56.3, besides two at 55.3, the English Great Northern maximum. In Great Britain there is only one line which compares with this French railway. The Caledonian Railway of Scotland has led all British lines in respect of speed since July, 1895, and still holds first place for the fastest booked run, —*viz.*, a short one of 32½ miles at 59.1 miles an hour, besides another at 56.5 and a third at 55.6., all unequalled on any other road in the United Kingdom.

When it is remembered that ten years ago the Northern Railway of France had no run booked faster than 43 miles an hour from start to stop, and that, without having the stimulus of competition, it has improved its services until now it has no fewer than 26 express journeys timed at a speed of 50 miles an hour and upward from start to stop, it will be realized how great has been the progress in a single decade. How admirable is the present service may be perceived by a glance at the following table of runs timed at 50 miles an hour or more:

STATIONS.	Distances in miles.	Times allowed. Hrs. min.	Average speeds in miles. per hour.
Paris—Amiens	81¾	1.25	57.7
Paris—St. Quentin	95¾	1.42	56.3
Boulogne T.—Amiens	77½	1.24	55.3
Amiens—Boulogne V	76¾	1.24	54.8
Paris—Amiens	81¾	1.30	54.5
Compiègne—Paris	52¾	1. 0	52.7
Paris—Longueau	79	1.30	52.6
Longueau—Paris	79	1.30	52.6
Creil—Amiens	50	0.57	52.6
Calais Pier—Amiens	104	2. 0	52.0
Amiens—Calais Pier	104	2. 0	52.0
St. Quentin—Jeumont	52	1. 0	52.0
St. Quentin—Paris	95¾	1.51	51.8
Paris—Amiens	81¾	1.35	51.6
Longueau—Arras	41¼	0.48	51.6
Longueau—Creil	47¼	0.55	51.4
Abbeville—Boulogne T	49½	0.58	51.2
Boulogne T.—Abbeville	49½	0.58	51.2
Amiens—Paris	81¾	1.36	51.1
Amiens—Abbeville	28	0.33	50.9
Amiens—Calais Ville	102½	2. 2	50.4
Paris—Creil	31¾	0.38	50.1
Creil—Paris	31¾	0.38	50.1
Amiens—Creil	50	1. 0	50.0
Tergnier—Amiens	50	1. 0	50.0

Such a list as this would be a credit to any railway—even an American one! How it contrasts with the English lines with which it connects by means of the cross-channel services may also be perceived by comparing the French Northern schedule above with the following, which is the best the South Eastern and London, Chatham & Dover lines can show in connection with the French services;

STATIONS.	Distance in miles.	Times allowed. Hrs. min.	Average speeds in miles. per hour.
Herne Hill—Dover (L. C. & D)	74½	1.35	47.1
Cannon Street—Dover (S. E.)	75½	1.44	45.3
Charing Cross—Folkestone (Direct) (S. E.)	70¾	1.34	45.1

It must be confessed that the contrast is not soothing to British insular pride. And this contrast is experienced by all travellers between London and Paris *via* Calais or Boulogne. Supposing a passenger to leave Paris by the 9 A. M. train for London, he experiences five runs, successively timed at 50.1, 52.6, 51.0, 51.2, and 47.[illegible] miles an hour, the last being along the short distance between Boulogne and Calais and over steep grades. Or he may leave at 11.50 A. M. and have two runs respectively at 51.6 and 50.4 miles an hour, to Calais. These trains cover the distance from Paris to Calais, one mile farther than from Manchester to Euston (London) and over a harder road, in, respectively, 29 and 33 minutes less than the fastest London & North Western time for that journey. Or he may go by the *train de luxe* at 12.20 and make his first run at 57.7 miles an hour, reaching Calais pier in 3½ hours, including a 5-minute stop at Amiens, this being 45 minutes quicker than the fastest time from Manchester to London, while the distance is two miles longer.

If it be said that there is some unfairness in comparing the best French service with some of the poorest in England, I may point out that my object is simply to show the astonishing advance made by the French railway, seeing that ten years ago even such a comparison would have been all the other way. But beyond this it may be observed that, whereas there is no train timed to do its first stage out of London at so fast an average rate as 54 miles an hour, the French Northern has no fewer than three booked to make the first run out of Paris at more than 54 miles an hour,—*viz.*, one at 54.5, one at 56.3, and one at 57.7. Moreover, the Chemin de Fer du Nord has two runs timed faster than any on the English Great Northern, three faster than any on the Midland, London & North Western, Great Eastern, North Eastern, Great Central, or London & South Western; 15 faster than the best on the Yorkshire & Lancashire; 22 quicker than any on the North British; and more than 30 faster than any on the South Eastern, London, Chatham & Dover, or London, Brighton & South Coast—with the single exception, in the case last-named, of the one train, restricted to a limited number of first-class passengers, which has just been put on from London to Brighton and back (50¾ miles) on Sunday only, to do the distance in 1 hour. And this takes no note of many excellent trains timed at 47 to 49 miles an hour.

The main line of the Chemin de Fer du Nord, after leaving the fine terminus situated in the Rue de Dunkerque, in the north-east quarter of Paris, goes nearly due north to Creil, 31¾ miles, where it bifurcates into two main lines. One takes a generally north-northwest course, to Amiens, Abbeville, Boulogne, and Calais—185½ miles from Paris; the other runs northeast to Compiègne, Tergnier, and St. Quentin, reaching Jeumont, on the Belgian frontier, and connecting there with a continuous chain of railways leading to Cologne, Berlin, and St. Petersburg. The distance from Paris to Jeumont is 147¾ miles. As these are the lengths on which all the best work is performed, I confined my attention to them almost exclusively. The Nord has other main lines to Soisson and Laon on the eastern side, and to Beauvais and Le Treport on the western, but the average speeds on those sections do not exceed 47 miles an hour, and are, as a rule, much lower.

It will be sufficient, therefore, if attention be confined to the two principal main lines of the four possessed by the Nord,—those to Calais on the one hand and to St. Quentin on the other.

The two have a common road as far as Creil, and diverge just beyond, 32 miles from Paris. For the first 4 miles after leaving the metropolis the line falls on an easy grade. Then, from St. Denis, there is an ascent for 12½ miles at 1 in 200, succeeded by a drop at 1 in 200 for about 15 miles. This brings us to Creil, where the line bifurcates. Continuing toward Calais, there is next a rise, practically continuous, for 23 miles, chiefly at 1 in 250 and 1 in 330, with shorter lengths at 1 in 400. Then comes a fall for 27 miles, also virtually unbroken, nearly all at 1 in 250 and 1 in 330. By this time Amiens is reached. In this distance of 81¾ miles two huge gables have to be climbed over, their sides being respectively 12½, 13, 23, and 27 miles, so that the road is by no means an easy one.

After Amiens an almost dead level extends for about 60 miles. Then the line rises 4 miles at 1 in 135, and drops for the same distance at the same rate. A short level and shorter climb brings us to Boulogne-Tintelleries station on the main line, a short branch leading to the other town station and to the pier. Leaving Boulogne-Tintelleries, the heaviest bit of the whole line has to be passed over, including an eight-mile rise at 1 in 125, somewhat broken, but 6 miles being continuous, and a continuous fall, also at 1 in 125, for eight miles, which brings us to the level area on which Calais stands.

On the other hand, if we turn off at Creil toward St. Quentin, we find first a 50-mile stretch of nearly dead level, having, however, a slight rising tendency. This is followed by a continuous rise at 1 in 333 for ten miles, and then a drop at the same rate for 5 miles, completing the journey to St. Quentin. This, though easier than the Calais line, is assuredly not the "unbroken level" which it is commonly represented as being.

Now, what are the engines which haul the trains at the high speeds shown in the tables. Up to five or six years ago all the express work on the Nord, which was then of a relatively mild type in respect of speed, was performed by engines of a class known as "Type Outrance," illustrated on page 795. This title probably was first given to them in compliment to their extreme speed,—they were the fastest engines on the continent,—and the name is retained.

It will be noticed from the illustration that the engine has what is very rare on the continent,—outside bearings for the coupled wheels, and external cranks for the coupling rods. Translating the French dimensions into the nearest English equivalents, I may say that the coupled wheels are 6 feet 10 inches in diameter, the cylinders are 17 inches by 24 inches, and the boiler has 1,082 square feet of heating surface and carries a steam pressure of 156 pounds to the square inch. The original pressure, however, was only 142 pounds. The total weight of the engine loaded is 43 tons, and the weight available for adhesion is 28 tons. Thus, allowing for differences in details and fittings, it will be seen that this engine was very much after the English type of a few years back, and even has many points in common with the latest design of the Great Western Railway.

At present they are not employed, as a rule, on the best express duty, but they occasionally take a turn on important trains, and I had several trips with them. Having regard to the limitations of their capacity, they did very good work. As much as six years ago the Nord mid-day express was run from Paris to Calais-Ville in 4 hours 9½ minutes, or 10½ minutes less than the present quickest time from Manchester to Euston, the latter being by a mile the shorter distance.

But they have long been utterly overweighted by the modern train loads, which have to be hauled at a speed never dreamed of in France in the days when they were built, and so the very able *ingénieur en chef de la traction*, M. du Bousquet, came to the conclusion that a new and important departure was necessary.

In view of the straitened limits imposed by the standard gauge of 4 feet 8½ inches on the development of boiler dimensions, M. du Bousquet became convinced that increased power must be sought in the more economical employment of the steam, and that some form of compound engine would best fulfil this desideratum. Accordingly he decided to adopt the type of four-cylinder compound which had been designed by M. de Glehn, *administrateur-directeur* of the celebrated Société Alsacienne des Constructions Mécaniques, which has extensive works at Belfort and Mulhausen, situated respectively on the French and German sides of the Alsace frontier. M. du Bousquet having specified the class of engine and the power desired and the details needed to suit the engine to the requirements of the Nord line, M. de Glehn proceeded to build, and up to the present time has constructed fifty of the four-coupled class, which now perform all the principal fast express work.

The first two that were built, which constitute Sub-Class I., were considerably smaller than their successors, although having the same diameter of cylinders and driving-wheels and the same length of boiler and piston-stroke. From the outset the diameter of the coupled wheels was fixed at 6 feet 11¼ inches, that of the two high-pressure cylinders at 13.4 inches, that of the two low-pressure cylinders at 20.9

inches, the length of the piston-stroke at 25.2 inches, and that of the boiler at 12 feet 10 inches between the tube plates. Stated roughly, it may be said that the high-pressure cylinders are 13½ by 25, the low pressure 21 by 25, and the coupled wheels 7 feet. The two pioneer engines, which were numbered 2.121 and 2.122—the first numeral, followed by a point, representing the *class* reckoned by the number of axles coupled—had a heating-surface of only 1,200 square feet in the tubes, those of the ordinary kind being used; the firebox added 117 feet, making 1,317 square feet in all. The fire-grate area was 22 square feet. The steam pressure was 198.7 pounds.

After two years' favourable experience with these engines, fifteen more (Nos. 2.123 to 2.137) were built, with largely-augmented boiler-power, the heating surface being increased to 1,553 square feet in the tubes and 117 feet in the firebox, or 1,670 square feet in all. With these engines the Serve tubes were used. Success still attending the compound engines, 20 more (Nos. 2.138 to 2.157) were constructed in 1895, forming Sub-Class III. These retained all the main dimensions of the earlier class, but adopted the enormous steam pressure of 213 pounds, working ordinarily up to 214 and 215 pounds. Finally Sub-Class IV. came out, in which the boiler power was much enlarged, the heating-surface being increased to 1,768 square feet in the Serve tubes and 122 square feet in the firebox, making 1,890 square feet in all, the fire-grate area being simultaneously enlarged to 24 square feet. These dimensions manifestly afforded vast capacity of steam-generation. One consequence of the progressive development was to raise the weights (loaded) from 47 tons, 16 cwt. in Sub-Class I., to 48 tons, 11 cwt. in Sub-Class II., 48 tons, 19 cwt. in Sub-Class III., and 50 tons, 9 cwt. in Sub-Class IV.,—the latest type. Another result was that a larger tender was employed, placed on two four-wheeled bogies and weighing 40 tons loaded. It carries 4,000 gallons of water and a proportionate supply of fuel.

In all the engines the two high-pressure cylinders are placed outside the frames, behind the leading bogie. They drive the rear pair of coupled wheels. The two low-pressure cylinders are inside, under the smokebox, and drive the double-throw crank-axle on which the front drivers are fixed. The two pairs of wheels being coupled, instead of running free with independent action as in the case of certain British engines, no trouble ever arises through a want of synchronism in the two sets of machinery, which constitute virtually two separate engines with one boiler and frame. I illustrate Sub-Classes II. and IV. of the four-wheeled coupled class of compounds on pages 796 and 797.

My observations as to the work of these engines may be divided into four classes: (1) special experiments with light loads at highest speeds, tested by elaborate methods in a dynamometer van; (2) similar experiments with ordinary fast expresses and moderate loads; (3) "surprise" journeys made without any previous intimation and without knowledge on the part of the officials that the work was being tested; (4) exceptionally heavy loads hauled at high speeds. The last two may be conveniently associated as one division of my subject.

In all cases excepting those of the "surprise" visits, most elaborate arrangements were made for testing the character of the work done. A four-wheeled dynamometer van was employed. It was placed just behind the tender, and had abundant side and front outlook, while it was fitted with all the apparatus needed for its functions. An automatic speed-recorder was actuated by a belt from one of the free-running axles of the van. An apparatus connected with the tender drawbar recorded the tractive force exercised. A broad band of paper moved by clockwork under two election pencils, one black and the other red, each operated by a button at the end of a cord, the two pencils being used by different inspectors, who noted with chronographs the passing of each station, signal-box, and kilometre-post. For myself, I used the arrangement of split-seconds chronographs described by me in the February (1898) number of this magazine, being thus able to note the time of passing every kilometre-post and point of interest. One inspector, who knew the road well, was specially detailed to watch for the posts, etc., and he gave five seconds' warning as each was approached. I can hardly imagine a more thorough and complete system of observation. I must express my thanks to two of the gentlemen who accompanied me on this interesting and memorable series of expeditions, and who took the principal part in making and carrying out the necessary arrangements, of course under the authority and instructions of M. du Bousquet, whose courtesy and kindness I cannot too warmly acknowledge. M. Jacoupy is one of the principal inspectors of the locomotive department of the Chemin de Fer du Nord, and I found him a most able and well-informed officer, as also was M. Rudloff, who is in charge of the locomotive depot, where are stabled the engines employed in the "Service Centrale" of the Nord. He always travelled on the footplate, and directed the respective drivers as to the special duty required of their engines at particular points of the road. M. Jacoupy took charge of the dynamometer van and, I may add, of myself. I cannot speak too highly of French hospitality and kindness as exemplified by him. Other gentlemen who assisted in the experiments were Messieurs Poupée, Pellieux, Poisson, and Channeur, to all of whom I desire to express my cordial acknowledgements. The results have no authentic parallels in Europe.

First in order among the trials was one with a train representing the "Rome Rapide," which is booked at 57.7 miles an hour from Paris to Amiens. An engine of Sub-Class IV. was used, and the load was 148½ tons behind the tender. In all cases the weights given are exclusive of engine and tender, the only accurate and scientific mode of computation. It may be well also to mention here that the maximum speed on all French railways is strictly limited by law. The Nord is allowed the highest point,—*viz.*, 120 kilometres per hour (74.4 miles) for ordinary expresses, and 125 kilometres (77.5 miles) in specially authorised cases. These limits are most rigidly adhered to; so my readers must not anticipate any exceptional maxima in these official trips. Some were attained in separate special experiments, but those I shall deal with apart from the others.

Starting the long ascent at 1 in 200 at 58 miles an hour, we kept at this speed for the first 4 miles. Then the speed rose to 59, and stayed at that for a couple of miles, 60 to 61 miles an hour being steadily maintained thence to the summit. The 12½ miles occupied exactly 12½ minutes. The descent toward Creil calls for no remark, but Creil station was passed, slowly, in 30 minutes, 32 seconds from Paris, the distance being 31¾ miles. In spite of our slowing through Creil, we rapidly attained 65.2 miles an hour up the 5 miles of 1 in 400 which is encountered immediately after Creil, and on a short level length intervening the rate quickly rose to 70. This was diminished to 62 by the following ascent at 1 in 250, but never fell lower to the top of that rise; and, when the grade eased to 1 in 330, the speed rose to 64 miles an hour, and was still increasing at the summit. In the subsequent descent toward Amiens the "special" legal limit of speed, 125 kilometres (77.5 miles an hour), was reached, but here, as in the previous descent, progress was interrupted by a bad slowing for heavy road-repairs, and a later check proved to be our too-early approach to our destination. This compelled us to "ease down," and we ran the last 5 miles with steam shut off. The distance of 81¾ miles from Paris, over the two "gables," occupied 79 minutes 56 seconds from start to stop, but, allowing for the carefully-ascertained loss of time, through road-repairs, — ordinary "service slacks" being ignored,—the net time was 76 minutes 24 seconds. On a subsequent occasion, with the train running in its ordinary course, the time was 79 minutes 13 seconds.

Next we experimented with the so-called "Nord Express," bound for Cologne, Berlin, and St. Petersburg, which is timed at 56.3 miles an hour from Paris to St. Quentin,—95¾ miles. The normal load of the "train de luxe" is about 100 tons, but on this occasion it was increased, by our dynamometer van and two extra 33-ton corridor coaches, to 178 tons. This militated against a speed-record, but showed to greater advantage the vast haulage-power of the locomotive, which was the same one used in the preceding case. In spite of the load being 30 tons heavier, the ascent of the 12½ miles of 1 in 200 was again made at an average rate of 60 miles an hour. Diverging at Creil, after the usual slack, our speed rapidly increased to 68.5 miles an hour on the long stretch of level and slightly-rising road, but, unfortunately, adverse signals brought us to a dead stand at Compiègne, 52¾ miles from Paris, this having been done in 51 minutes net. Resuming, we attained 69 miles an hour on the level, and sustained 65 up the bank of 1 in 333. The train being much before time, the downhill length to St. Quentin was done without steam, the running time from Paris being 95 minutes 9 seconds for the 95¾ miles, or 90 minutes 48 seconds net. It should be noted that during this run the speed at no point exceeded 70 miles an hour. All the gain of time was in the uphill work. On a second occasion the trip was done in 94 minutes with the normal load.

But the final run of this series proved in some respects phenomenal, as the fastest from start to stop ever made in Europe. The engine was one of the same class; the load was the normal one *plus* the dynamometer van, or 114 tons 7 cwt. in all behind the tender. In this instance the uphill running greatly surpassed anything in my previous experience. So quickly did the engine gather speed that we were running at 60 miles an hour in two miles from the start, 70 in three miles, and 71.3 in four. Here we began to climb the 12½-mile bank at 1 in 200, and up the whole of that length the speed averaged 67 miles an hour,—the highest average achieved during the Aberdeen race, including downhill and level. In this case the whole distance was uphill. The speed ranged between 65 and 69 miles an hour, the former being through stations; it was 68 and still rising when the summit was attained. The subsequent descent to Creil was made at the maximum speed permitted,—*viz.*, 77.5 miles an hour,—and Creil (31¾) miles was passed in 28½ minutes from the Paris platform. Along the 50 miles of level and slight rise which succeeded, a rate of 75 miles an hour was persistently maintained, interrupted only by faint slackenings past stations or junctions; in one case this speed was run without variation for 10 miles on end, all the distance being level or slightly uphill. Then came the 10 miles ascent at 1 in 333; starting this bank at 40 miles an hour, after a slack through Tergnier, the speed steadily rose all the way up, until, just before the summit, the rate was 70 miles an hour; it was still increasing when the summit was passed. These uphill performances are without parallel in my experience. The run from Paris to St. Quentin was done in 85 minutes 11 seconds net, or at an average speed of 67.4 miles an hour.

The gross time, including what were practically three stops for crossing backward and forward at the points where single-track working was necessitated by heavy road-alteration,—cases in which French practice exists on exceptional precautions,—was 91 minutes 52 seconds, start to stop. The net time, 85 minutes 11 seconds makes no allowance or reduction for the regular service slacks at Senlis Junction, Creil, Compiègne, or Tergnier. These, however, if taken into due account, represented a further loss of fully 5 minutes. If those two were subtracted, the result would show that the actual locomotive-work was an average speed of 71 miles an hour up and down grade, and without allowing for the gradual attainment of speed after starting, or for the gradual slowing before the stop. This would undoubtedly have been exceeded in a similar American run, because the downhill speed would have risen to 88 or 90 miles an hour; but this is not permitted in French practice with regular trains. That the engines can attain the highest speeds yet authentically known is, however, certain; for once, when making a special trial, I obtained a speed of 85 miles an hour on a falling gradient, and the engine then was not exerting its full power. The rate was rapidly mounting when the foot of the slope was reached, and an uphill length succeeded, so that on that occasion no increased velocity could be got.

Proceeding next to my experiments with the ordinary fast expresses having moderate loads and running in their customary course, I may select, for my first illustration, the "Calais-Basle" express, which ran nightly during the summer, and was timed to make the journey from Calais pier to Amiens, 104 miles, in 1 hour 58 minutes, including a 2 minutes' stop at Boulogne-Tintelleries, the run of 77½ miles thence to Amiens being booked to be done in 84 minutes, or at the average rate of 55.3 miles an hour.

A late arrival of the boat from Dover made our departure more than half an hour late; so considerable scope was afforded for "making up." Unluckily heavy permanent-way works were in progress about half-way up the long bank of 1 in 125 to Caffiers, compelling single-line working and consequent delay. Thus on the first stage to Boulogne, nothing particular could be done, and our energies had to be reserved for the next stage—to Amiens. I have already described the road. The engine was one of the 2.158 type—Sub-Class IV. Fig. 3—the latest and most powerful type. The load consisted of eight vehicles, including a dining-car weighing 32 tons; the total weight behind the tender amounted to 134 tons.

Notwithstanding the obstacle already mentioned, which involved a delay of 3 minutes, the distance of 26¾ miles from Calais pier to

Boulogne-Tintelleries was done in 28 minutes 51 seconds, although there was an up grade at 1 in 125 for nearly 11 miles of the way. But from Boulogne onward a clear run was secured to a point a mile short of Amiens, where more road-repairs brought us almost to a standstill. The length of 76½ miles from Boulogne to that point was run in 70 minutes 53 seconds, but, owing to the check, the final mile into Amiens station took 3½ minutes, making the total time from Boulogne (77½ miles) 74 minutes 23 seconds, from which 1 minute 53 seconds should be deducted for the delay. However, this run to St. Roch, where the delay occurred,—*viz.*, 76½ miles in 70 minutes 53 seconds,—would have been an excellent one in any circumstancess What rendered it specially remarkable was that it was accomplished without once exceeding a maximum rate of 70 miles an hour. That maximum was only once just touched, all the rest of the way the speed varying between 63 and 68 miles an hour. Thus even the prescribed ordinary limit was not reached, the maximum attained being 112 kilometres as against 120 authorised. This shows a surprising evenness and steadiness of running. It should be noted that the train made up 9 minutes 37 seconds, or, if the check be taken into account, 11½ minutes, on a timing at 55.3 miles an hour.

The corresponding train, being only a few minutes late in starting, was unable to do all that might otherwise have been done. As it was, Boulogne was reached from Amiens in 77 minutes 29 seconds, a minute before time, the load being the same as in the other case cited, but the engine was one of Sub-Class III., instead of Sub Class IV.

In the case of the 10.30 A. M. express from Paris to Boulogne, the running-time allowed is exactly 3 hours for the 158¼ miles. A stop of 20 minutes is made at Amiens for *déjeûner*. This, of course, I have excluded from the time-calculation. On the occasion when I tried it the engine was one of Sub-Class IV., and the load 145 tons behind the tender. The run of 81¾ miles was accomplished with the utmost ease in 82 minutes 58 seconds, showing an average rate of 59.1 miles an hour. The maximum speed was kept well under the legal limit, and the ground was got over by fast uphill work, 62 miles an hour being steadily maintained up the 12-mile bank of 1 in 200. The journey was made in 7 minutes 2 seconds under time. The continuation to Boulogne was done in 6¾ minutes within time, the 76¾ miles to Boulogne Ville occupying 83¼ minutes under easy steam.

Dealing next with my "surprise" journeys, made without previous intimation to the authorities or knowledge on the part of the officials, I may select two particular experiences. In each case the train was the day mail from Calais connecting with that leaving London at 9. A. M. This train has to run the 184¼ miles from Calais-

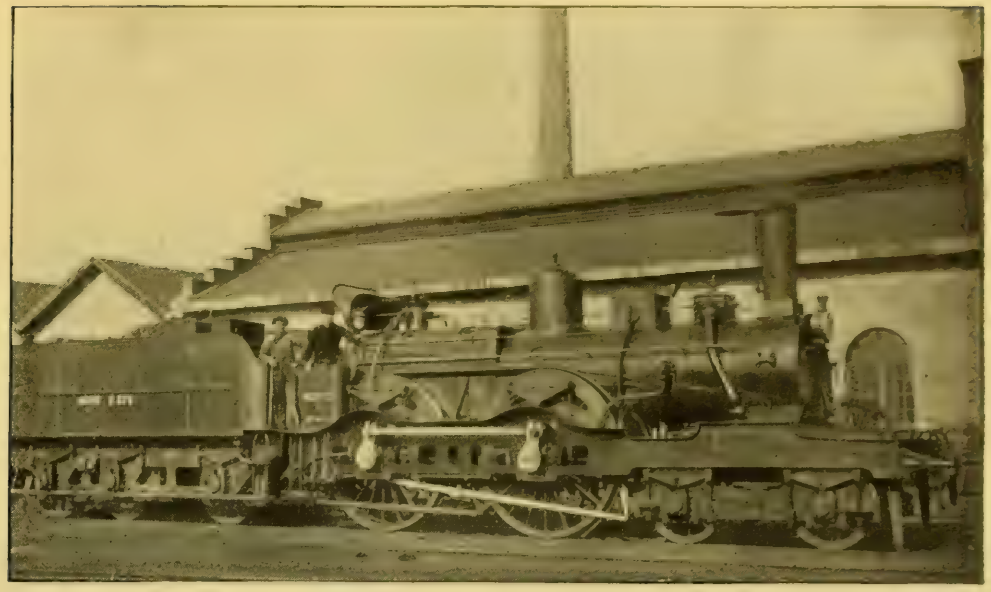


FIG. I. NON-COMPOUND EXPRESS ENGINE, CHEMIN DE FER DU NORD, FRANCE.
"Type Outrance," predecessor of the four-cylinder compound.

Ville to Paris, over the road already described, in 3 hours 54 minutes with four stops aggregating 9 minutes. In each case the engine was of Sub-Class IV. In the earlier journey the load throughout was twenty coaches, weighing, in all, 265 tons, exclusive of engine and tender. Owing to baggage and customs detentions at Calais, the departure was 18 minutes late, and the train had to stay 10 minutes over time at the stations, beside being stopped thrice by signal. Nevertheless, the engine actually gained 23½ minutes in the running-time with that load, and in spite of those drawbacks. A speed of 41 miles an hour was maintained up the 8-mile Caffiers bank at 1 in 125; 62 on the level between Boulogne and Abbeville; 53 to 55 up the banks at 1 in 250 and 1 in 300 after Amiens; while the 15-mile ascent of 1 in 200 after the start from Creil to the Survilliers Summit was mounted in 20 minutes 6 seconds.

In the second case the load was eighteen coaches (268 tons) from Calais to Amiens and twenty (290 tons) thence to Paris. Starting from Calais-Ville 16 minutes late and staying 10½ minutes over time at the stations,—four in all,—the train, although then 26½ minutes late, actually reached Paris a minute before time, having thus gained 27½ minutes on the schedule! This remarkable feat was achieved though the smart work up the banks. Up the 8 miles of the bank at 1 in 125 to Caffiers 42 to 43 miles an hour was sustained; up the 25 miles of 1 in 250 to 1 in 333 after Amiens, 53 miles an hour; and, up the 13 miles of 1 in 200 after Creil, 50 miles an hour was the minimum. I could quote other performances of similar merit.

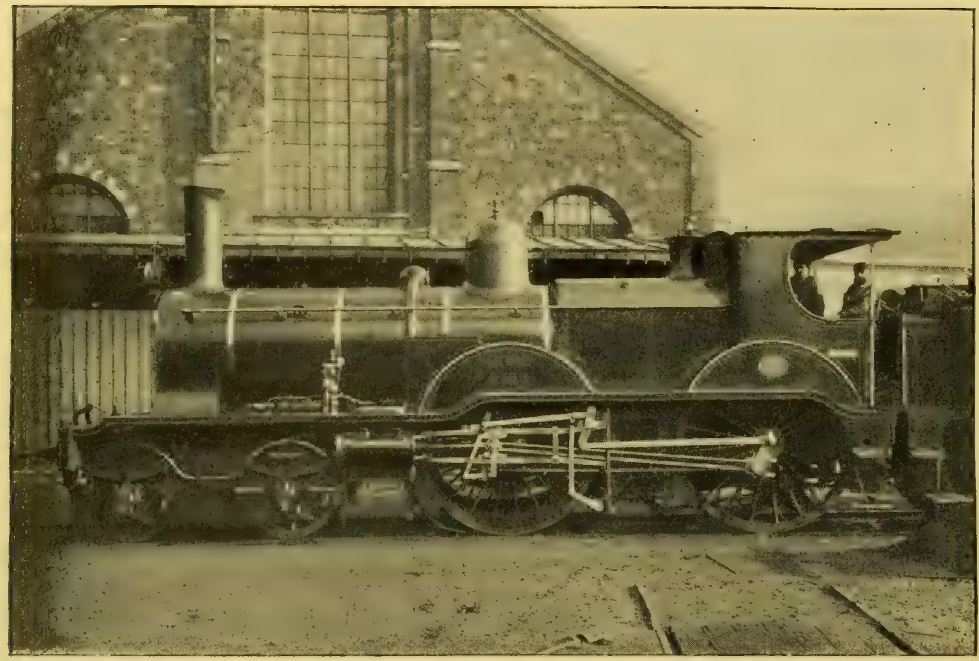


FIG 2. FOUR-CYLINDER COMPOUND EXPRESS ENGINE. SUB-CLASS II.

Among my experiences with heavy trains fast-timed, a run with the Lille corridor express holds a high place. The engine was one of Sub-Class IV., and the load aggregated 270 tons 6 cwt. Timed to run the last 79 miles from Longueau Junction (2¾ miles on the Paris side of Amiens) to the Gare du Nord, Paris, in 90 minutes, or at 52.6 miles an hour, the engine succeeded in gaining 3 minutes 52 seconds. The start had to be made at the foot of a 23-mile ascent of 1 in 333 to 1 in 250. Up this grade 52 miles an hour was persistently sustained, there being only one drop to 51.6 in passing over station points, while the speed actually increased to 55 up the steeper gradient of 1 in 250 toward the summit. Up the long stretch of 1 in 200 after Creil, 50 miles an hour was maintained, and for official reasons no faster rate than 70 was run down the descent approaching Paris.

A journey with one of the earlier type of 4-cylinder 4-coupled compounds (Nos. 2.123—2.137), Sub-Class II., was noteworthy. The engine hardly differs from the later type, the only points of variance being that its steam-pressure is 199 pounds instead of 213. Taking the Cologne-Paris fast express from St. Quentin to Paris, exactly 2 hours being allowed for the 95¾ miles, the engine drawing a load of twenty coaches, or 274 tons, the run to a signal stop just outside the Paris station was made in 1 hour 53 minutes 25 seconds, although there was a loss of fully 5 minutes through the heavy permanent-way alterations mentioned in connection with the fast trip in the opposite direction. Work of this sort calls for no comment.

Following in some degree a point of recent American practice, the Chemin de Fer du Nord has introduced a new type of engine, originating, like the others, at the ateliers of the Société Alsacienne, and designed by M. de Glehn, in consultation with M. du Bousquet as to details specially suitable to the French Northern line. These engines, which are numbered 3.121 to 3.170, run on ten wheels, six being coupled, and have four-wheeled bogies. They have 1,950 square feet of heating-surface, 24.4 square feet of grate area, and 213 pounds of steam pressure. Four-cylinder compounds like the other types referred to, these have two 13.8-inch high-pressure cylinders, outside, and two 21.6-inch low-pressure cylinders inside. The piston stroke is 25.2 inches. The six coupled wheels are 5 feet 8¾ inches in diameter. Loaded, these engines weigh 58 tons 12 cwt., without tender.

Although designed chiefly to run heavy stopping trains and fast goods trains, these engines occasionally take their turn at express work; indeed, they regularly run certain expresses which are heavily loaded and have steep grades to contend with. They sometimes even take the fast mails between Paris and Calais. I had several trips with them in this work, and found that they invariably perform it with the utmost ease. That the heaviest train loads permitted by law in such services would be child's play to so powerful engines, even up the steepest banks on that line, is obvious; but a specially noteworthy feature of their performances was the ease and readiness with which

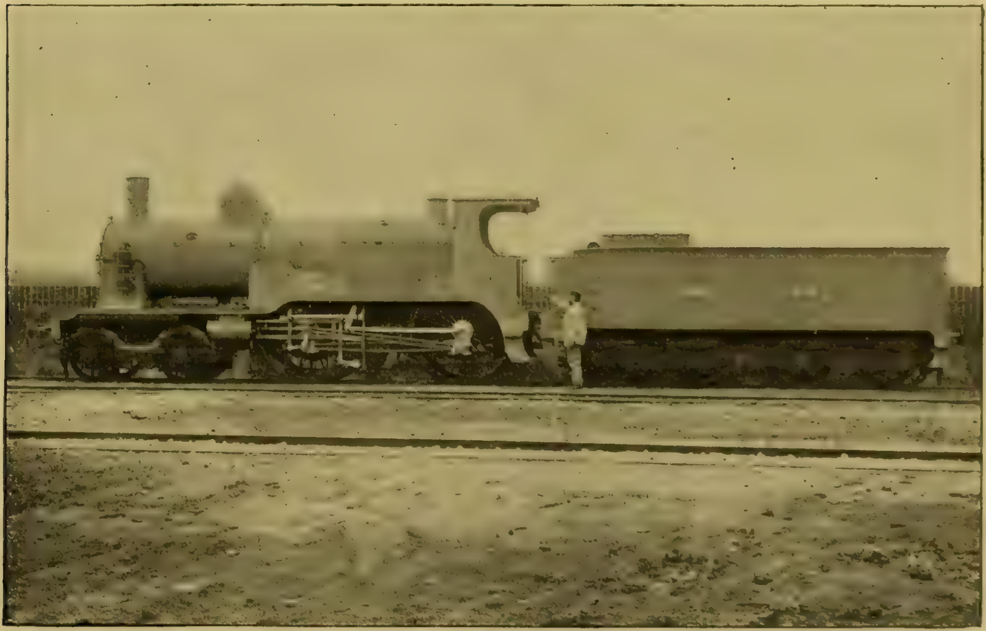


FIG. 3. FOUR-CYLINDER COMPOUND EXPRESS ENGINE. SUB-CLASS IV.
Latest type of Four-Wheel Coupled. Chemin de Fer du Nord.

they ran at high speeds, such as 70 to 73 miles an hour, for many miles together, travelling as smoothly as a single-wheeler and always arriving with cool bearings.

But one of their achievements, even in weight-pulling, was exceptionally fine, considering the speed. The engine was put on the heavy Lille express from Paris, which is timed to its first stop, Longueau, at 47.4 miles an hour. The train consisted of 24 coaches, carrying more than 700 passengers and a vast amount of baggage, the total weight being 340 tons. The journey was made in 6 minutes 43 seconds less than the schedule time, in spite of a signal stop which caused a loss of 4 minutes 37 seconds; the actual net time for the 79 miles was 88 minutes 40 seconds, representing an average speed of 53.3 miles an hour. Starting after the signal stop on an ascent of 1 in 200, the engine, hauling 240 tons, attained 40 miles an hour in two miles from the dead start, with that load up that grade, and then steadily got up to 47 miles an hour, which was sustained to the summit. I have never before recorded so fine up-hill work. Going up the bank, 23 miles long, after Creil, the engine went steadily at 48 to 51 miles an hour, holding the faster rate to the end of the 1 in 250 and improving to 52 up the final length of 1 in 330, this speed actually rising as the summit was attained. I have no instances of such work, up-grade, in all my voluminous British records.

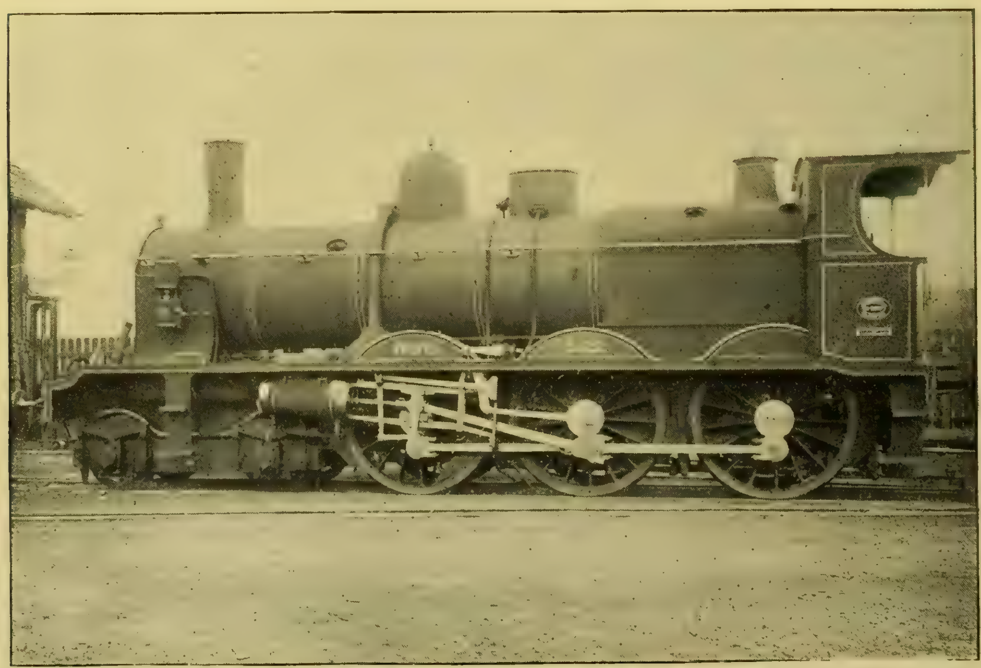


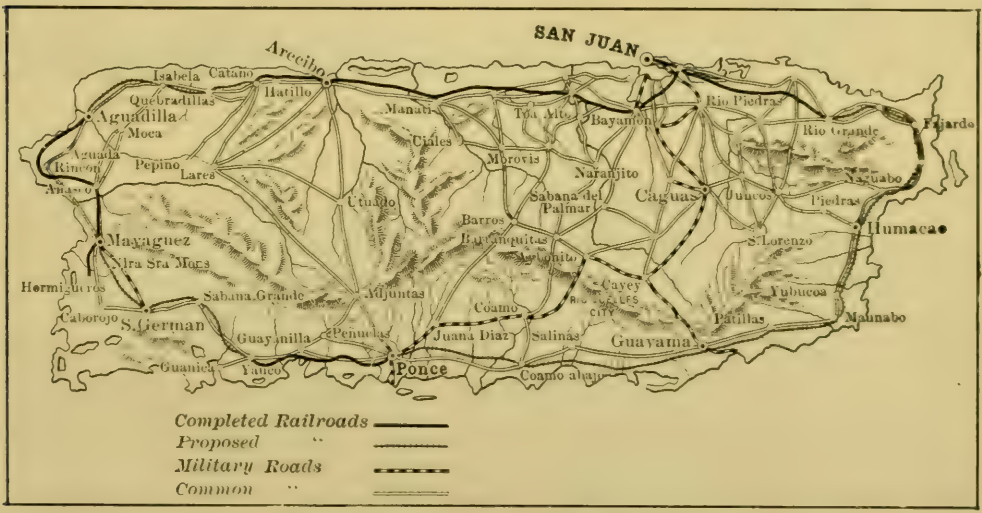
FIG 4. TEN-WHEELED FOUR-CYLINDER COMPOUND LOCOMOTIVE, CHEMIN DE FER DU NORD. NEW SIX-WHEEL COUPLED TYPE.

THE EXPLOITATION OF ELECTRIC TRAMWAYS IN PORTO RICO.

By Antonio Mattei Lluveras.

THE establishment of electric tramways throughout the island of Porto Rico, from east to west along the central range of mountains, would be desirable, easy, and relatively inexpensive. An electric line, starting from Naguabo or Humacao at the east end, touching the interior towns of Juncos, Cáguas, Aguas Buenas, Sabana del Palmar, Barranquitas, Barros, Jayuya, Utuado, Adjuntas, and Maricao, and terminating at Mayagüez, with branches from the main line to the villages along the coast, would serve, better than any other system, to move the rich products of those districts and to accommodate the great number of passengers who now have no means of convenient travel.

The coal problem, and many other expensive items of railroad building, would not be a consideration in the operation and construction of such a tramway system, as there exist throughout the whole mountain range natural water powers available for any class of machinery. The many and powerful waterfalls having their sources in the mountainous inland region, and the rivers which run through this territory in various directions, seem to have been created by nature especially to aid man in the cultivation of the rich soil and the marketing of its products, which, because of the high altitudes and



MAP OF THE ISLAND OF PORTO RICO.

necessarily heavy grades of high-roads, if these should be built, would otherwise be very costly. The interior of the island is extremely mountainous, as may be well seen from some of the illustrations. Around the entire extent of its coast, however, is a flat belt of rich lowlands, suitable for the cultivation of sugar and tobacco.

The highest village of Porto Rico, Aybonito, situated at an altitude of 2,300 feet above sea-level, is on the line of the central highway which runs from Ponce to San Juan. This fine highway, built originally by the Spanish government for military purposes, has no grade greater than 14 per cent., which would be the maximum also to be met with in the construction of a tramway along the mountain range.

THE TOWN OF PONCE, PORTO RICO.

The ballasting of road-beds, in whatever direction the lines might run, would cost but little, as there is more than enough material for this purpose on the ground; and throughout the whole extent of the proposed lines there is to be found wood of excellent quality for cross-ties. The labor required for such a construction is abundant and comparatively cheap, as the laborers in this region, accustomed to the hardest work, have never earned more than 75 cents a day (Porto Rican currency); and it would be an exceedingly easy matter to procure 2,000, 3,000, or 4,000 men for any kind of an enterprise.

Skilful stone cutters are easily to be had; and on the ground along the route is found an ample supply of stone suitable for bridges, culverts, and other constructions of a similar nature. In short, it will not be necessary to seek elsewhere the materials for the construction of a tramway or railroad, as all, excepting the rails and other metal parts, are to be had along the mountain range. With abundant and well-distributed water power, from streams that do not fail even in the dryest seasons; with the materials for ballast and ties at hand; with labor cheap, good, and plentiful—the building of electric railway lines will certainly be attended with but little cost compared with the substantial profits that such lines may be expected to earn.

In the whole island, whose coast line measures 339 miles, there exist at present only the following steam railway lines, belonging to a French company:

One line, of one meter gauge, from San Juan to Camuy, with the following eight intermediate stations, Bayamón, Dorado, Vega Baja, Manatí, Barceloneta, Cambalache, Arecibo, and Hatillo. This is sixty-two miles long, and its operation produces an average income of $2,735 per mile annually.

Another line leaving San Juan on the north, passing through Martín Peña and Rio Piedras, and terminating at Carolina, is 14 miles long. But the income from its operation is not so great, as another steam railroad runs in the same direction for half the distance, or to Rio Piedras, thus dividing with it the traffic of that region.

BOAT LANDING AT PONCE.

Still another line, 35 miles long, runs from Aguadilla to Hormigueros, with intermediate stations at the following villages: Aguada,

THE CUSTOM HOUSE WHARF, PONCE.

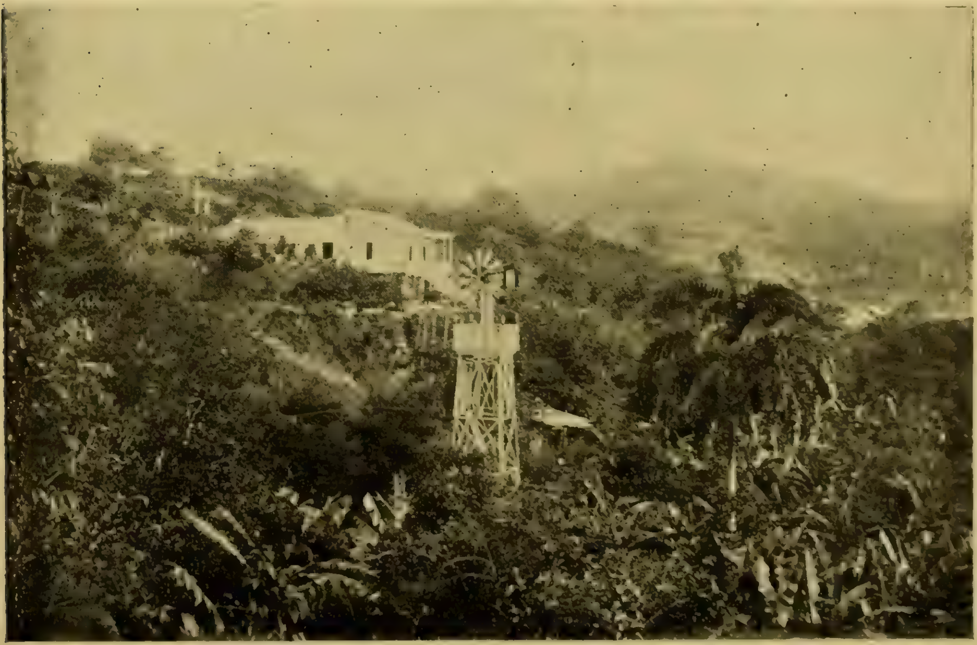
Rincón, the Corçica plantation, Añasco, and at the beach and city of Mayagüez.

Another short line is in operation between Yauco and Ponce, a distance of 22 miles, with two stations on the line at Guayanilla and Tallaboa. This railroad has an average annual income of $2,760 per mile, but it should be noted that, because of the high freight rates, $2.25 per ton for a 22-mile haul, or ten cents per ton-mile, a great part of the freight-carrying between Yauco and Ponce is performed by ox-carts, in successful competition with the railroad. The freight rates of the ox-carts are not much lower than those of the railway, and the speeds are about the same. Besides this excessive charge, the railway does not offer the facilities which should obtain in this district, as it does not reach to the harbor of Ponce, where the great bulk of business is done. Bulk must be broken and the goods transferred, the transportation of merchandise and fruits from the railroad station to the harbor front by carts being a very costly item, as well as a source of great inconvenience.

The company which constructed these railroads had a concession from the Spanish government for building a line completely around the island, with a guaranteed interest of eight per cent. upon the capital employed in its construction; but the term of the concession was extended twice or oftener without a realization of the project, although the company earned more than eight per cent. from the time it began the operation of the two small sections which have been actually finished. The island has not, therefore, enjoyed the expected benefits from the railroad, as so little of the line is constructed that only the towns between Camuy and San Juan are in direct communication. There exists also a railroad line from Mayagüez to Lares, passing through Añasco, which is the property of a private stock company; but it is operated only to the small town of Las Marías, the rest of the road being in course of construction.

Porto Rico has only one great highway, called the Central, which runs from the port of Ponce to San Juan, a distance of 83 miles, touching several points of little importance, such as Juana Diaz, Coamo, Aybonito, Cayey, Cáguas, and Rio Piedras. This highway is joined at Cayey by another of similar character, coming from Arroyo, the port of Guayamo, distant 22 miles. The greatest grade in either road is 14 per cent. But none of the towns not directly on the highways can make use of them, owing to the lack of branch roads leading to them. These main roads are indicated on the accompanying map by heavy dotted lines, the other roads shown being little more than horse tracks.

There are other highways in course of construction, such as those from Ponce to Adjuntas, from Rio Piedras to Rio Grande, and from San German to Maygüez; but none of them has yet been of much benefit, as they are finished only in short sections. Without doubt



A COUNTRY HOUSE NEAR PONCE.

they will be abandoned the day that better means, such as electric tramways, are furnished for transporting products.

It is this lack of communication throughout the island which curtails production, imposes stagnation upon the inhabitants, and impedes the development of many industries which could otherwise be established. The present difficulty of transportation is almost incredible. With no roads save those mentioned above, the moving of heavy articles is almost impossible. Coffee plantation machinery, and the like, when the single parts are too heavy for one mule, are put on a sort of sledge and dragged along the ground by oxen. Nothing can be more primitive, and at the same time more expensive, than such methods, as certain figures given below go to show.

The convenience of construction and the need for electric tramways throughout the island being thus established, it is easy to see that the movement of products to and from the interior must render satisfactory returns to any enterprise which gives to the people those advantages of easy communication and transportation required for the development of the country.

Official statistics for the calendar year 1897, which was certainly one of the least productive of the past decade, show that the exports of the island were as follows :

	Cwt.	Value.
Cane sugar	125,323,589	$ 4,007,999
Molasses	25,085,069	403,519
Coffee	51,097,823	12,222,598
Tobacco	6,181,771	1,194,318
Hides	822,108	71,852

There was produced, of course, a considerably greater quantity of each of these products, the difference going to the home consumption of nearly a million inhabitants. The total exports for 1897 are given in the Spanish "Estadística General" as $18,574,678.45.

Besides, there is a large production of minor fruits which do not figure in export commerce, although they are of considerable importance in interior transportation. If these fruits could be quickly and cheaply moved to the coast, for shipment to American markets, there is no doubt that a large and profitable trade in them could be quickly established.

The territory which produces the most coffee is in the high and mountainous parts of the island, along the central range, and here it is that the greatest need is felt for transportation facilities, the only existing means of communication being by horse roads or mule paths built by the residents. From the plantations where the coffee is gathered to the nearest towns on the coast, whence the berries may be carried in ox-carts to the markets, carriage is effected, at the present time, on the backs of horses and mules, which can take only 200 pounds a trip. These same horses bring back an equal quantity of provisions and merchandise for the subsistence and necessities of the laborers and other inhabitants of the interior. For this transportation on horses and mules $1 a hundred pounds, each way, is paid from the points most distant, and 50 cents from the nearer points. Among these rich coffee plantations are some of considerable importance, such as the Esperanza of Pietri brothers in the jurisdiction of Adjuntas near the Guilarte range, which produces 3,000 to 4,000 cwt. at each gathering. This plantation employs a daily personnel of 350 laborers and pays $1 per hundred pounds for transportation to the town of Yauco. In the jurisdiction of Yauco the plantation Candelaria, of Pedro Olivari, produces 2,000 cwt., and pays a dollar per hundredweight for transportation. The plantation Mogotes, the property of Messrs. Pieraldi, also produces 2,000 cwt. of coffee of the very best quality, and pays 50 cents a hundredweight for transportation. The plantation Tres Hermanos of P. Cardie gathers and sends out 2,500 cwt. at an expense of 75 cents for transportation. The Santa Clara plantation, of Mariani's sons, gathers 7,000 cwt., employing a thousand men daily during the gathering of the fruit, and pays from $1 to $1.50 for transportation. The plantation of Sr. Vilella, in the jurisdiction of Lares, gathers some 4,000 cwt., paying $2 per hundredweight for

A LANDSCAPE ON THE PORT ROAD, PONCE.

SUGAR HOUSES OF THE MERCEDITA ESTATE.

its transportation to Mayagüez. There are at least 300 plantations along the same range, side by side, in the short distance between Maricao, Yauco, and Adjuntas. One of the illustrations shows the process of drying the coffee berries in the sun, large sliding racks on which it is spread being employed for this purpose. The berries are spread out on the racks and raked over in the strong sunshine, the rails and rollers being simply for convenience in handling the racks.

Cane sugar, which is cultivated only on level ground and close to the coast, claims but seven plantations which produce centrifugal

ON THE ROAD FROM PONCE TO ADJUNTAS.

sugar. Of these may be mentioned the plantation Fortuna of the Gallart estate in Vega Baja; those of Jorge Finlay in Vega Alta, of Bianchi Pagan in Añasco, of Rodulfo Perez in Humacao, of Cintró in Yabucoa, of Borda in Canóvanas, of Rio Grande, and the Mercedes plantation of Sr. Serrallés between Ponce and Juana Diaz. The grinding and other houses of this plantation are shown in the illustration. There are several plantations in the island which produce about 16,000 cwt. of cheap brown sugar per annum, and there are many which for some time have been given over to pasture lands, but which could be reclaimed and would yield a large production, if intelligently and scientifically cultivated.

The transportation of sugar from the plantation to the nearest coast shipping point is generally effected in hogsheads of 15- to 16-cwt. capacity at a cost of 20 cents per cwt. as a minimum and 32 cents as a maximum, except from the points where the railroads pass, very few to be sure, where it costs but $\frac{2}{3}$ cent per cwt. per mile.

DRYING COFFEE ON A PORTO RICAN PLANTATION.

Porto Rico, while essentially agricultural, is very backward in its methods of cultivating the soil, and in the quality of its sugar production—the chief element of its wealth. Besides the multitude of plantations of relatively small size which are devoted to sugar production, there exist great extents of level land, abundantly fertile, that can very easily be given over to sugar cultivation if large central grinding mills, working under economical conditions, are established.

The lowlands of San Germán, consisting of more than 45,000 *cuerdas*,* all very level, where there are now some 25 small cane plantations, could very easily be brought under one central grinding mill, the owners associating themselves for the purpose of bringing there the necessary implements for the improvement of the crop, while enjoying the further benefits to be derived from the introduction of improved machinery for the extraction of the juice. Here, again, is an opportunity for the application of electrically transmitted power, generated from the torrential streams of the mountains which are nowhere far distant from the coast.

A PORTO RICAN TOBACCO FIELD.

There exist also, in Guánica, some 20,000 *cuerdas* of swamp land, belonging to the government, which could be easily drained and made to produce 900,000 cwt. of sugar annually. Adding to this some 4,000 or 5,000 *cuerdas* included in the plantations Manantial, Fraternidad, and Desideria, which have irrigation plants, it will be seen that there could be established here a central grinding mill of considerable importance at a point near to the best port of the island of Porto Rico. This port of Guánica, endowed by nature with superior topographical conditions, has also been selected by fate as the site of the most important acts in the history of the beautiful island. It is the port from which the Spaniard, Juan Ponce de León, sailed on the 3d of May, 1512, to discover the island of Biminí and the Florida coast; and it was also the port selected by the American navy for the beginning of the occupation of the island, which was completed on July 25, 1898.

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* A cuerda is about four-tenths of an acre.

There is another great plain of 70,000 *cuerdas* in Guayama, which could be devoted to cane production, although in this part of the island irrigation would be necessary on account of the long droughts which prevail there. This could be obtained, however, from the Plata river, and more than one survey has been made with this in view. The fertile plains of Yubacoa, Humacoa, and Naguabo, which extend inland, by way of Juncos and Cáguas, are of such extent that ten or twelve large central grinding mills could be profitably established there, as well as in the plains of Rio Grande, Carolina, and the large fields of Arecibo.

A PALM HUT FOR DRYING TOBACCO.

It is undoubted that the imports of the island are of no less importance than its exports in assuring positive returns to any electric-tramway enterprise devoted to the transportation of produce, as it is evident that nearly every class of articles for consumption must be brought from abroad. The home products of the island are not such as to support the population, exchange of the native sugar and tobacco against food products and manufactured goods being continually necessary.

The last official statistics present relatively respectable figures, and it is advisable to have them in mind when speaking of the commercial relations of the country. The commerce of Porto Rico with the United States, notwithstanding the high customs duties, amounted, in 1897, to $3,749,815 of imports. The imports from other countries were as follows:

Spain	$7,152,016
Germany	1,314,603
England	1,755,754
Cuba	692,780
France	215,473
Other countries	2,977,622

This represents a difference of $2,240,652 between imports and exports, the excess being in favor of the former.

A detailed examination of the kinds of goods imported from Spain will show that nearly all will come in the future from the United States if their protection be established in this newly-acquired country.

The imports from Spain during the past year (1897) were classified as follows:

Cotton, wool, silk, horse-hair, metals, chemical and pottery products	$2,739,780
Wines, liquors, and oils	2,423,158
Animal products, employed in the industries, such as shoes, boots, gloves, lubricating oils, greases, etc.	1,160,242
Stationery and manufactures of paper	288,036
Woods and manufactures of vegetable products	279,076
Hemp, thread, and manufactures of vegetable fibres	242,620
Machinery and agricultural implements	19,104
Total	$7,152,016

The production of tobacco in Porto Rico also has an interesting future, and is bound to become the basis of a good business in the United States. Its cultivation there is easy and inexpensive, but it has recently fallen off because of the duties with which its export was burdened. One of the illustrations clearly shows the luxuriant growth of tobacco in a Porto Rican field.

The Porto Rican tobacco is equal in quality to that produced in the island of Cuba, and a large part of the famous tobacco which is exported from Havana and Santiago de Cuba under the name of "Vuelta abajo" is from Porto Rico, yielding large returns to Cuban enterprises. The manufacturers in Cuba buy the tobacco in Porto Rico, unstripped, and, after preparing the leaf, reship it at excessive profits which are due solely to the name "Havana tobacco." The highest price obtainable by the cultivators of tobacco in Porto Rico never exceeds $28 a cwt. for run of leaf, and in these lots there is frequently found from 25 to 30 per cent. of superior leaf, which is afterwards exported from Cuba at $100 to $125 a cwt. simply because it appears to have been grown in Cuba.

Owing to the import duties which were placed on Cuban tobacco in Porto Rico two cigarette factories have been established recently—one in San Juan, called the "Cooperativa," and another the "Internacional" in Ponce. These factories have no competition in their line, and yield handsome returns, while giving employment to a large number of persons. They prefer to work tobacco from Cayey, Cáguas, Comerio, and Juncos, that from the plains of the Plata river being the best grown in the island.

Factories for manufacturing tobacco leaf exist in several towns of the island, particularly at Cayey, Ponce, Mayagüez, and San Juan, but the larger number of the tobacco-growers prefer to devote their energies to raising leaf for the preparation of chewing-tobacco, which they manufacture themselves. This is consumed by the laboring classes and yields relatively better profits, as it sells at 50 cents a pound.

These statements, based on actual figures, are sufficient to demonstrate that North American capital will find ready employment in Porto Rico for the improvement of interior communication, contributing to the agricultural and industrial richness of the island, and establishing the close relations which should exist between it and the American federation.

THE DEPRECIATION OF PLANT, AND ITS RELATION TO GENERAL EXPENSE.

By H. M. Norris.

IN accepting the invitation to supplement my article on cost-keeping with a second one, in which general expense should be made the chief subject of discussion, it was my purpose to give a digest of the practices of a number of metal-working establishments; and, with this end in view, I addressed the following letter to ten widely-known machine-tool builders.

I have in course of preparation an article on the depreciation of machinery, in which I should like to make mention of the practice of six or eight of our largest and best known firms.

The principal points that I wish to cover are as follows:

1. What do you consider the average life of a 12-inch, a 24-inch, and a 48-inch lathe; a 24-inch, a 48-inch, and a 96-inch planer; an upright drill, a milling machine, and a gear cutter—all of standard make—working under average conditions?
2. When do you consider that a machine begins to depreciate in value?
3. How would you figure depreciation on the above tools?
4. How do you regard small, loose tools, such as drills, reamers, taps, mandrels, milling cutters, etc.?
5. How do you regard belting?
6. How do you value your line shafting, including pulleys, hangers, and couplings?
7. How do you value your standard drawings?
8. How do you value your standard wood and iron patterns?
9. How do you value your standard jigs and fixtures?
10. How do you value jigs and fixtures that are used only occasionally?
11. How do you value such articles as vices, anvils, cranes, and chain hoists?
12. How do you value your work-benches, stock bins, and other shop fixtures?
13. To what do you charge repairs on machine tools?
14. Into how many items do you divide general expense, and what are they?
15. How do you apportion your general expense to the various articles you manufacture?
16. What is your general scheme of taking inventory?

But I find that I reckoned without my host, as will be seen from the following letters:

DEAR SIR,—The force in our office capable of answering intelligently such questions as you ask is always fully occupied, and just at the present time, owing to vacation season, is entirely too busy to take up and answer the large number of questions that you ask.

DEAR SIR,—While we are willing to show people every attention at our works, and help them in any way that we can to an understanding of our methods, we do not feel like going into all the details of our private business affairs in the way you have suggested. We say this to you in all kindness, and think you will appreciate the spirit in which we write you. In shops where people would be most likely to give such information it would probably be of the least value. At least, that has always been our experience.

Your first question, "What do you consider the average life of a 12-inch, a 24-inch, and a 48-inch lathe," we would reply to by saying that the difference between the extreme abuse of tools and the extreme care that is taken in some places would be very wide, and it would require considerable labor to get at the average wear and tear.

A short time ago we took a spindle out of one of our No. 6 screw machines that had been running about eight years. This spindle had, of course, hardened bearings at both ends, made of Jessop steel, and the fine marks of it made by the grain of the emery when it was ground were still on the spindle. This in the first place was a first-class spindle, and had been taken excellent care of. If the same spindle had been put in of some soft steel, running in babbitt or cast iron instead of phosphor bronze, and had also been very poorly cared for, it might have become useless in two years. This is simply to illustrate the difficulty in getting at what a fair average would be.

DEAR SIR,—We are in receipt of your favor of the 3rd, and regret exceedingly that we cannot comply with your request concerning our methods of proportioning our expense and other items to which you refer. We feel that this is, in a measure, private information that we do not care to have disseminated generally. We would like very much to accommodate you personally, but believe you will appreciate our position in this connection.

DEAR SIR,—We would have no objections to answering your several questions if we could do so verbally, but we cannot spare the time to answer by letter, as it would be too voluminous, and require too much explanation. If you should be in our neighborhood before your proposed publication, and will call upon us, we will be glad to discuss the matter with you.

DEAR SIR,—We reply to the questions in your favor of the 3rd inst. as follows, which we trust will be satisfactory to you:

1. Depends upon the care they receive; if they receive proper care, I should say one hundred years, or until it is profitable to change them for improved tools.
2. If not taken care of, say one week; if it is, it may be twenty-five years.
3. As above, most people make it 5 per cent. per year.
4. Depends on how much they are used, and what care they get.
5. This depends upon the kind, place it is used, and the work done. Our main belt, with some repairs, lasted thirty years.
6. 5 per cent off annually.
7. At cost several years ago, and have, since this item of cost was established, let it remain at same figure, with year additions of not less than $12,000 to $15,000.
8. At cost.
9. At cost.
10. At cost.
11. We first make a cost price, and carry the total along from year to year, and make no note of cost of repairs and additions.
12. At first cost, with no increase for many years.
13. General expense.
14. One item, including everything but labor and material.
15. Average 75 per cent. of the amount paid for machinist work, or about 17 cents per hour.
16. Work finished, wrought, raw, and in process, at cost; tools in shop, at cost when new, 5 per cent. discount each yearly inventory. Yours truly,

THE PRATT & WHITNEY CO.,
F. A. PRATT.

MY DEAR MR. NORRIS:

* * * * * * *

It is very easy to figure up a large inventory account, increasing it each year, and at the same time be drifting toward bankruptcy at a breakneck speed; in other words, many companies who think they are doing a successful business and making money are, before they know it, hopelessly involved, and have to make an assignment. It may seem to you that our answers indicate that we are somewhat conservative, but that is a pretty safe side to be on. * * *

1. Depends on the ability used in the designing and manufacture and care in use. In cases of alleged "cheap tools" it is often most profitable to condemn them before starting.

2. High-grade tools most valuable when new. Depreciation begins quickly. Low-grade tools are in a sad state of dissolution before completion.

3. On the basis of above facts, allowing about ten per cent. per year for good machine tools.

4. As a necessary expense which soon pays for itself; so we don't count them in inventory.

5. Same as number 4.

6. We consider them as permanent fixtures, and inventory them as a part of the building.

7, 8, 9, 10, 11, 12. Charge to expense account and make no further note of them. (One exception in No. 11,—*viz.*, cranes we include in answer to No. 6.)

13. Charge ordinary repairs to expense account. Charge to the machine, if it is practically rebuilt.

14. Charge to expense account all items you cannot send a bill for, excepting such as add to the permanent inventory.

15. By percentage on monthly shop expenses.

16. Make generous reduction on previous year's valuation on old tools, and value new tools and supplies at cost.

Very truly yours,
W. R. WARNER.
(WARNER & SWASEY.)

DEAR SIR:—We are in receipt of your favor of the 3rd, and beg to advise you that, our shop being small, employing only from one hundred to one hundred and fifty men, we are unable to establish systems and carry them out as a large shop could afford to do.

We believe in many of your systems that are established in many of the large shops. We, however, understand that what a shop can do which employs one thousand men it would be impossible for a small shop to copy, as we do not want to spend five dollars to save one. In regard to your questions, we would state as follows:

1. We consider the life of all machines in our establishment at about ten years.

2. We consider the depreciation in value of a machine begins from the time it is started.

3. We figure the depreciation of a tool at about 10 per cent. a year, and that the life of the tool is figured at longer than ten years. The cost of repairs is such that it would equalize the total cost. If you have a tool in your establishment, and it has been there for twenty years and is in good condition, you will probably find that the repairs on this tool have been in that length of time fully as much as the cost of a new machine.

4. The small tools in our establishment are placed under shop expenses, with the exception of when the tool is for some special machine, in which case it is charged against the cost of that machine.

5. Belting is charged as shop expenses.

6. The line shafting, including the pulleys, hangers, and couplings, are considered as part of our plant.

7. Our standard drawings are charged as plant; drawings of special machines are charged to the cost of that machine.

8. We would say that our standard patterns are charged with plant, and patterns of special machines are charged against that particular machine.

9. We value our fixtures and jigs as plant.

10. Would say we have no jigs and fixtures which are used only occasionally, as special tools are very seldom built in this way.

11. Vices, anvils, cranes, etc., are charged as plant.

12. Work-benches are charged to plant; stock bins and other shop fixtures that are upon or attached to buildings are charged to building expenses.

13.. The repairs on machine tools are charged to each tool and deducted from the 10 per cent. which has been allowed from the cost, as stated in reply to question number three.

14, 15, 16. We cannot answer unless going into a detailed letter, which we do not think would give you the necessary information. We would, however, at any time you are in Philadelphia, be pleased to have you call and ask any questions you wish to know.

Hoping this letter will prove of some use to you, we remain, Yours very truly,

NEWTON MACHINE TOOL WORKS, INC.,
H. W. CHAMPION, *Sec'y.*

A nation's progress is dependent upon the distribution of knowledge, and knowledge withheld is progress retarded. This is equally true of private enterprises, and I think it will be admitted that one of the chief essentials of progress, especially in the mechanic arts, is unselfishness—a willingness to exchange ideas, a broad and liberal policy, fostered by an *esprit de corps* which insures its own reward.

Profits of manufacture are not gained until interest on capital and loss by wear and tear of plant have been provided for. Many firms overlook both of these items, and fancy they are earning money when, in reality, they are living on their capital alone. Every neglect, or error, in this direction will, according to its extent, render calculations of cost and profit fallacious.

The depreciation of plant is an extremely troublesome problem, and it is probable that there is no phase of an industrial undertaking in which results show so wide a range of variations. This applies alike to drawings, patterns, jigs, fixtures, small tools, and standard machinery, and is particularly noticeable in the valuations placed upon plants of "going" concerns. It is, of course, impossible to formulate a rule whereby the annual shrinkage in value of a plant can be determined mathematically, but some general principles may be be kept in mind with advantage. Mr. Ewing Matheson, in his admirable book on "The Depreciation of Factories," says on this subject:

In regard to the proper rate of depreciation for machinery, there is, even in well-managed factories of similar class, a wide divergence of practice. Thus, in a new factory doing a profitable business, private partners will, in their desire to be on the safe side, sometimes commence by writing off annually 10 per cent. from machinery of all kinds. Unless there be some apprehension of the plant becoming obsolete, this is generally too liberal a rate for fixed machines, unless it is neutralized in some other way. In other cases, the records of many years' working may show that 2½ per cent. is sufficient, because the machinery was good in kind and quality to begin with, partly also because the expenses of installation and of liberal repairs have been defrayed out of revenue, and partly because the machines have been moderately worked.

In engineering factories the rate which will probably meet the deterioration will generally be found between 5 and 10 per cent. Where the work is of a moderate kind, which does not strain the machine severely, and where the hours of working do not average more than sixty per week, 5 per cent. would generally suffice for machinery, cranes, and fixed plant of all kinds, if steam engines and boilers be excluded. Where there is a diversity of machinery and plant, and the past accounts of twenty years to refer to, it is not difficult to arrive at an appropriate rate and to make periodical revisions.

Mr. J. Slater Lewis states in this connection, in his exhaustive and extremely valuable work upon "The Commercial Organization of Factories,"

> "There can be only two sound ways of dealing with the depreciation of the plant and building of mechanical engineering establishments,—*viz.*, (1) that of making adequate provision for the wear and tear of machinery and buildings by setting aside, out of revenue, a sum of money equal to the net depreciation, or (2) that of spending such money on plant renewals and repairs each year. If there are no profits out of which such provision may be made, or such renewals and repairs effected, then capital account will show a loss equal to the amount of the depreciation. It therefore follows that no dividends can be paid, and, probably, no interest debentures, until such sum has been set aside. Nor does this apply only to the current year, since it appears that no dividends can legally be paid in subsequent years, until capital previously reduced by depreciation has been made good out of earnings.
>
> Although some firms keep their plant in first-class order, and effect such repairs from time to time as maintain it in good working condition, still it cannot be denied that all machinery is constantly being superseded by something more efficient, and that it is only a question of time in any case when it would be more economical to put some of it on the scrap-heap,—in fact, necessary to the very existence of the firm to do so. To only repair plant to make good depreciation cannot, therefore, be wise or sufficient. And yet to buy new plant regularly, or even at all in the early stages of a new concern, would, in order to comply with the requirements of depreciation, be absurd.
>
> The soundest way to deal with depreciation is to keep all plant in thorough repair, and, *in addition*, to set aside, out of revenue, a sum of money which, in a given number of years, will purchase an entirely new series of machines. Any old machines that may be sold or scrapped in the meantime should be replaced out of the fund, and any new machine which is a virtual *addition* to plant charged to capital account. The cost of a new machine to replace an old one should be reduced by the value of the scrap, or by the sum for which it may have been sold.

It is obvious from the foregoing that the capital account plays no small part in the financial administration of a manufacturing establishment, and that general expense is not covered until provision is made for the loss by the wearing-out of the machinery of production, to which must be added the interest on the cost of the entire plant, as well as on the working capital required by the business.

To facilitate a correct estimate of the valuation and subsequent depreciation of plant, it is expedient in many cases to separate assets into a number of distinct general categories, and to deal separately with each,—such, for instance, as the classification suggested in my former paper: A. Standard drawings; B. Standard patterns; C. Standard machinery and tools; D. Special tools, jigs, and fixtures; E. Line shafting and accessories; F. Office and shop fixtures; G. Belting; H. Miscellaneous.

The first on the list is standard drawings. How should they be valued, and how depreciated? Mr. Lewis omits the question entirely in his work, while Mr. Matheson says merely that "engineer's drawings should be charged to the particular work for which they have been made, but there may be a permanent value to be considered in the case of valuation for a change of ownership." At the Newton establishment "standard drawings are charged as plant, and drawings of special machines are charged to the cost of that machine." The Pratt & Whitney Company valued their drawings "at cost several years ago, and have, since this item of cost was established, let it remain at same figure, with yearly additions of not less than $12,000 to $15,000." Here we have three distinct, widely-varying practices. In the first, drawings are given no book value whatsoever; in the second, they are charged to, and, presumably, depreciated with, plant; while, in the third, they are treated as pure, unshrinkable capital—capital which, for some reason, is regarded as proof against the ravages of time with its "absolutely staggering" progress "in rendering existing machinery obsolete." Drawings are not merchandise. They are merely a means to an end,—a necessary evil in production, much akin to a salesman's salary.

A drawing serves two purposes; it shows, first, how work *should be* done, and, second, how work *was* done. It may be said to continue to represent value in the first capacity so long as it is used in production, while in the second capacity its value is practically nil. Drawings of special machines should, of course, be charged to the specific work for which they were made, for, unless they control future orders, they have no place on the books of the company. Standard drawings, however, are clearly chargeable to capital, not as assets from which a given percentage can well be written off annually, but as assets whose real value at any time can only be approximated by a system of debits and credits.

Those drawings which are the workman's sole guide will depreciate in value in proportion to the decline in the sale of the machine they represent, while those which are replaced by samples, templates, jigs, etc., shrink in value at once, becoming useful as records only. The first may remain as an asset equal in value to their first cost, until diminished by decline in the manufacture of the articles they represent, reaching finally the class of records otherwise known as discarded drawings. When, however, a shop is equipped with a full set of modern, well-designed jigs and fixtures, where all tools are set and measurements taken from samples, the conditions are different, rendering a further division necessary. Standard drawings must be separated into "assembly" and "detail" drawings. The former retain their value as long as the machines they represent continue to be sold, while the latter retain their full value only until replaced by other shop guides, when, in all probability, they will be laid away, to be used at rare intervals as reference records. Drawings of jigs, fixtures, etc., should be charged as expense on the particular work they illustrate, and, after having been once used, should take their place with the special and discarded standard drawings, being written off the books at once—leaving as assets only those drawings which remain in constant use.

The next item demanding consideration is standard patterns, the vicissitudes accompanying an accurate determination of the value of which are so numerous and varied in character that most manufacturers have recourse to little else than guess-work, either in their appraisement or in their manner of dealing with depreciation. When seldom used, patterns have little value; if used often, they soon wear out. Hence one is frequently at a loss to know just what disposition should be made of them. Some prudent firms write off all patterns at once by debiting them to the first machine, or first lot of machines, made from each, while others go to the opposite extreme, and charge them to capital, with no regard to depreciation from year to year. Both systems have the advantage of simplicity, but simplicity is their only virtue. Patterns usually represent too much money to be so summarily dealt with. If added to capital and permitted to stand on the books of the company at cost, as it is by some firms, the business will show an inflated value, while to write them off at once is unjust to the original owners, as in a repetition trade it is frequently expedient to make a set of patterns which may have a value greatly in excess of the castings made from them the first year or two.

The value of a pattern may be said to depend upon three things, exclusive of accidents,—*i. e.*, its construction, the extent of its use, and the care with which it is handled. A strong, well-made planer pattern should withstand the making of a hundred castings before more than minor repairs are necessary; an engine pattern, a hundred and fifty castings; and some simple patterns, such as are made in a snap flask, as many, perhaps, as a thousand. A pattern should never be permitted to remain in the sand longer than is positively necessary, and should always be carefully brushed after removal. It should be kept well varnished, and should be stored in a cool, dry place, protected from the rays of the sun.

There is always a natural reluctance to treat costly patterns as valueless; yet the moment one becomes obsolete, or in any way loses its usefulness, it is an incumbrance, however satisfactory it may be to look at, and should be broken up for fire-wood or scrap iron, as the case may be, rather than allowed to occupy valuable space, consuming money every time it is handled.

Patterns can seldom be satisfactorily treated in the accounts by the system of writing off a given percentage annually, and should never be valued or depreciated *en masse* by any system, unless they are made entirely of iron. They should first be classified according to the permanency of their capital value, and the cost of each accurately recorded in a pattern-book. Patterns for standard machines are always subject to more or less alteration in design, and are consequently worth less than those for standard gears, pulleys, hand-wheels, collars, etc., which, by their adaptability for any mechanism requiring such parts, have a much longer useful life. And patterns for jigs, fixtures, repair jobs, or to meet breakdowns, are of less value than either of the above. Then again, patterns for standard machinery made in large quantities differ vastly in value from those for machines rarely sold. It is obvious, therefore, that, in order to arrive at any considerable degree of accuracy, a separate and distinct rate of depreciation must be set for each class of patterns, and even then results should be checked by a complete re-valuation every few years.

In questions of this kind, the chance of a pattern becoming obsolete is a factor of considerable importance, and cannot be too strongly emphasized. Alterations in design not-infrequently render a whole set of patterns obsolete before they have been used a dozen times. It is upon its *trade life*, therefore, rather than its possible life, that the valuation of a pattern should be fixed. Hence, the soundest and most effective method is to treat every pattern, or set of patterns, individually—on the assumption that a live, standard pattern has a value equal to the proportion of life still extant. That is to say, the present value of a pattern is to its original cost what the probable number of castings that will still be made from it is to the sum of the castings already made and still likely to be made, or, to express it arithmetically: Total likely castings: Castings still likely:: Original cost: Present value.

If a pattern costing $20 is likely to be wanted for, and will withstand the making of, fifty additional castings after having been used for one hundred and fifty, it is obviously worth only one-quarter of its original value, and should be written off accordingly—the proportion reading: $150 + 50 : 50 :: \$20 : x = \$5.00$.

Patterns chargeable to customers' orders do not, of course, add any book-value to the general stock of patterns, since it is assumed that they are of no general value, even though left unclaimed by the customer. Likewise, patterns for jigs, fixtures, special tools, attachments to plant, etc., are practically worthless so soon as they have been used for the purpose for which they were made, and should not, therefore, be permitted to figure as an asset. Further, patterns for parts of machinery that are furnished merely as repairs cannot be regarded as in the same category with those from which castings are much more frequently made.

Generally speaking, four classifications will be found sufficient to meet the requirements of the machine-tool builder: (1) patterns for jigs, fixtures, etc.; (2) patterns kept for the repair of *former* standard machinery; (3) patterns for *present* standard machinery; (4) patterns for such standard parts as are common to a large number of machines. Each of the classifications may be denoted by adding a figure to its distinguishing letter, as B1, B2, B3, B4. With such a classification before him, the pattern-maker will have little difficulty in charging the respective patterns to their proper class, as they are made. To make all patterns as if of one class, and afterwards to allocate them to separate heads, is, of course, possible, but highly inconvenient in practice.

Class No. 1 cannot be regarded as possessing any value whatsoever. The value of No. 2 depends entirely upon the nature and extent of the business, but should, in prudence, be written down very liberally. No. 3 had best be treated individually, as suggested above. Patterns of class No. 4, if made of iron, as such patterns usually are, may be regarded as of almost permanent value; little or nothing need be written off for their depreciation, providing, of course, that all repairs (varnishing, remarking, etc.,) are charged to general expense.

EDITORIAL COMMENT

In examining the engineering work of the month in technical literature, as recorded in the columns of The Engineering Index, a number of notable subjects attract attention; and, indeed, there is no better way to follow the trend of progress in the domain of engineering than to glance over the classified titles of the articles there presented.

* * *

In the field of electricity must be mentioned Professor Lodge's notable contribution to the development of space telegraphy, his paper before the Institution of Electrical Engineers, reviewed at length elsewhere, forming a remarkable account of the possibilities to be expected in the near future from the application of the magnetic-wave method. Other noteworthy papers dealing with the general subject of magnetic waves are also found, showing the continuance of interest in this fertile department of electro-physics.

Extending use of electricity as a motive power for traction must be noted; it is gaining favor both for elevated roads in cities and for overhead and underground trolleys in city and country, as papers from various parts of the world indicate.

* * *

In municipal engineering the vital subject of pure water supply is still the leading question. Filtration continues to be the favored method of removing injurious matter from drinking water, but the enormous consumption of water in many large cities, due in most cases to uncontrolled waste, makes this method of purification a difficult one to install. The bacterial processes of sewage purification, which continue to meet with favor and endorsement from the highest experts, may go far to remedy the difficulty of impure drinking water by removing much of the original pollution; hence the two subjects of water-supply and sewage disposal appear in close relationship.

The subject of automobilism continues to grow in interest, if the space allotted to it in the technical press may be taken as a guide. In fact, the automobile seems to be rapidly emerging from the "freak" state and entering into the sober realm of everyday work. To automobile cabs succeed self-propelled carriages for physicians, and to these again omnibuses, vans, and trucks; with the increased attention which is being given both to the motive power and the running gear of these vehicles, very practical results may be anticipated.

* * *

As might have been expected, the unique experience afforded in New York by the burning, during a high gale of wind, of a very combustible structure by the side of a modern tall building has called forth a number of articles upon fire prevention and fire-resisting construction, this subject being also discussed at length elsewhere in this issue of The Engineering Magazine.

Passing to other forms of structural work, the most notable descriptions included in the index are those of the completion of the great steel-arch bridge at Berne, and of the new bridge over the Rhine at Düsseldorf, while further accounts are given of the progress of the Alexandre III. bridge at Paris.

* * *

In the United States, especially, the engineering work which is likely to follow upon territorial expansion continues to furnish material for discussion, as is shown by articles upon the relations of the engineer to national expansion, together with others indicating more specifically the lines along which the earlier and more important undertakings may be expected.

Isthmian-canal projects continue to attract attention, the revived Panama scheme appearing as a competitor of the proposed Nicaragua canal. That the isthmus will be pierced at some point now appears to be generally conceded, and the only questions for discussion are the still important ones of location, political influence, and the actual physical problems of construction.

Among hydraulic and electric power plants, the projection and execution of which form such an important feature in modern engineering, may be named the proposal to improve the navigation of the canal of the Iron Gates, on the Danube, by the construction of locks, and at the same time to utilize more than 20,000 h. p. of hydraulic power thus made available.

* * *

The subject of economy in generation and application of steam power always forms a conspicuous feature in mechanical engineering; the principal points being actively discussed at present relate to efficient combustion, in the case of steam generation, and to the mooted question of the wastefulness or economy of cylinder compression in the case of steam engines. The main factor in the waste of steam in engines having been detected in the form of cylinder condensation, the best method of diminishing this waste seems as yet undetermined. Multiple expansion seems rather to have lost favor as compared with superheating—or, rather, the united advantages of both are emphasized at length in papers of authority and value.

* * *

Recent investigations made by the German government into the diminution in the strength of copper at high temperatures confirm earlier researches in the same direction. They point to the advisability of using some other material where both stress and heat are acting upon the metal, as in the cases of high-pressure steam pipes, fire boxes, and the like.

In mining work the usual annual reports of mine disasters are found, while activity in the direction of safer mining explosives and more effective protection against firedamp continues unabated, Germany being especially active in this field. Increasing demands by iron manufacturers have led to the investigation of new ore fields, and iron ore will probably continue to be the theme of mining literature for some time to come.

* * *

The month has been busy in all branches of engineering, and but a brief *résumé* of the salient features can be here given.

In the Engineering Index, however, will be found direct reference to all the details, as reported by the technical journals of the world, and it is to the Index that the seeker for detailed information must be directed.

* * *

Viewed along economic lines, the crowding signs mark this as the age of trusts instead of the age of steel—which, however, suggests a closely kindred idea to the ear, if not to the eye.

The small investor has come out of his hiding; financial waters teem with fat and fatuous fish, scurrying madly into the dragnet of the promoter—to be squeezed for their grease.

The ways of trust promotion are simple; shut out foreign trade by a "protective tariff,"—stifle home competition by all combining together—mark up your goods to any extent dictated by your fancy, or your ideas of wealth and—there you are! All the world grown rich together. How beautiful!

But supply can not be absolutely cornered, nor demand autocratically coerced. Individualism can not be bound; someone always stays out—some stone is lacking in the projected arch—and, when the centering of over-confident promise and expectancy is taken out, the inevitable collapse follows. The promoter, who turned his inflated shares into cash at the height of the speculative madness, is not found in the ruins; the gasping investor is.

And this demoralizing and decadent movement will continue until its artificial source is destroyed—until the nation realizes that the "protection" now needed is the protection of honest and honorable direction, of skillful management, and of economical production—the protection of wide-spread trade, won by supremacy in a fair and manful struggle with the world and maintained in a world-wide competition under fair and equal conditions.

It is not surprising that Mr. Warren's article on "The Fighting Engineers at Santiago," in our January issue, should have awakened an outcry in certain quarters. It is hard for many minds to realize that criticism may go hand in hand with warm sympathy—that a thing which was done marvellously well, may have succeeded in spite of grave defects, and that the wisest course is to look the defects in the face and, by mending them, make success surer the next time.

It is surprising, however, to find that few of Mr. Warren's critics know that most of his "charges" may be found clearly confirmed in the official reports of Admiral Sampson. This lends a particular interest to Captain Chadwick's communication, which many papers have taken as a reply to Mr. Warren, while it proves on examination, to be a confirmation.

The thanks of The Engineering Magazine are most cordially extended to Captain Chadwick for his attention. It is a matter for further satisfaction that his comment "has the indorsement of Admiral Sampson." The essential thing is that the truth be made clear, by resort to the fixed facts and the highest authorities, and The Engineering Magazine welcomes correction, where it is needed, as warmly as it does endorsement.

If the distance from the Morro to the Colon be forty-nine miles, instead of forty-five as Mr. Warren stated, it is right the fact should be brought out; but Captain Chadwick himself suggests a doubt as to the accuracy of the chart on which all the measurements are based. Mr. Warren's purpose, however, was not to establish any geographical details, but to serve the nation and the navy,—the bridge as fully as the engine room—by drawing serviceable lessons from the first actual test of the existing order under fighting conditions.

It is here that Captain Chadwick's contribution is most valuable. He strongly confirms Mr. Warren's argument—exactly in some points, generally in others, in which a different basis of measurement makes a close comparison impossible.

Mr. Warren says the forward engines of the New York were disconnected; Captain Chadwick confirms it, and the same thing applies to the Brooklyn. Indeed, it is so stated in Admiral Sampson's official report. Mr. Warren says, of the New York, "there were boilers disconnected, empty, and of course fireless"; Captain Chadwick agrees that there were—two disconnected and fireless, one of them empty. He says nothing about the steam pressure in the four which were fired.

In statements of speed, there are slight differences. Mr. Warren considers the race from start to finish; Captain Chadwick takes intermediate points. Thus he gives the New York's time "until she *slowed down* as she neared the Colon"; he states the respective speeds of the New York and Brooklyn as being 14 and 13.2 knots (Mr. Warren gave 11.06 and 13.06)—but Captain Chadwick's figures are between "points of departure taken after the chase was well begun," while Mr. Warren considers the whole time of running, including the slow getting under way due to the unpreparedness which is his principal theme.

Captain Chadwick says no salt water was put into the New York's boilers; Mr. Warren did not assert that there was. He does say, as the engineer of the New York has since said, that the Brooklyn's empty boilers were filled with sea water after the chase began, and he knows his facts. That it was true of more than one ship, in spite of the "circular order of Admiral Sampson's of May 29" which "covered this matter in great detail," is established by authority of Engineer-in-Chief Melville, who says: "There was trouble on several ships with collapsed furnaces due to the formation of scale in consequence of the forced use of salt water for extra feed." It is freely indicated in Commodore Melville's official report, and officially admitted as regards the Texas.

It is evident that, with this possible exception, there is no real controversy in matters of fact between Captain Chadwick and Mr. Warren. The significant part of the captain's statement is his extenuation of the facts. Coal economy, he thinks, was more important than readiness to use full power at any moment. There would seem to be little cause for satisfaction in a policy which did, indeed, require the New York to withdraw less frequently for recoaling, but crippled her for the meeting with the enemy which was the whole purpose and expectation of the blockade. Mr. Warren gives the idea that the bridge officers did not realize, when they imposed these conditions of economy, how hard it would be to rise to the always-imminent emergency when it should finally come. In this connection his paper has its immediate value. It makes clear the difficulty which will be necessary and permanent so long as the ordering of the movement of the ship and the management of her motive power are in the hands of different authorities, neither of whom understands the work or the difficulties of the other.

From the nature of the case, the source of the information in Mr. Warren's article can not be disclosed. THE ENGINEERING MAGAZINE assures its readers that the information is beyond all question. With this reaffirmation of the accuracy of every essential particular, THE ENGINEERING MAGAZINE desires to couple a most earnest statement of its position. It desires to create no sensation, to excite no controversy, to make no charges, least of all to detract from the credit of any gallant officer or of the fleet which won so magnificent a victory at Santiago.

It desires solely to advance the effectiveness of the navy; to help every officer to a position of fuller command of his ship, in every phase of its structure and work; and to aid in establishing, throughout the entire body of officers of our navy, a standard of ability as high and as single as their devotion to duty and to the flag.

* * *

The Payne bill is in the House Committee on Merchant Marine and Fisheries and the nations are again invited to witness Uncle Sam in his great act of lifting himself over the fence by his boot-straps.

With fine irony, the bill is described as being "for the encouragement of the American merchant marine"; similar "encouragement" has nearly wiped the American merchant marine from the seas, and confined to home coasts the flag which used to be seen in every port of the world.

The sea is essentially free, and its mastery is won by struggle with opposing elements—not by coddling at home in the sun. As easily raise sailors on a mill-pond as ship-owners under protection.

While the House committee are debating amendments designed "that Mr Hogan's company might be included" or that the "Norfolk and Western railroad * * * should receive subsidies for twenty years," England is making more secure the carrying trade she has now.

When the United States adopt a free-ship policy, their ships will be sailed, and eventually built, as well and as cheaply as any. Until that time, American shipbuilding will exist as an exotic in an atmosphere which stifles the carrying trade.

* * *

An item in the technical press may sometimes journey for a long time and through devious paths. The Engineering Index provides a kind of identification bureau, where each new disguise is penetrated or *alias* noted. An amusing specimen of the journalistic waif, probably still upon its travels, is a paragraph describing an apparatus for electrically regulating the engines of a ship in a sea-way, so as to shut off steam if the screw is thrown out of water. Its original appearance, so far as is known, was in a French journal. From this it was taken, without credit, by an Italian journal. Another French technical publication adapted it from this, translating it again into French and reproducing the illustration. This time it was duly credited to the Italian paper in which it was found. From this French reprint an American electrical paper made a translation in abstract and, as the illustration was somewhat the worse for its many re-reproductions, had a new drawing made. Here again it was credited to the Italian journal. From its American contemporary still another French journal re-translated the paragraph into French and reproduced the redrawn illustration. The next appearance of the description is awaited with interest. Its journeyings, as described, occupied nine months.

THE BRITISH PRESS

Review of Leading Articles

Improvements in Space Telegraphy.

RECENT developments of methods of ether-wave telegraphy have given great impetus to the study of a variety of systems for space signalling or "wireless telegraphy." The history of the subject is very old, comparatively speaking, as experiments were seriously undertaken in Scotland about fifty years ago to obtain data for the construction of a system for telegraphing to and from America. This was, of course, years in advance of the first cable projects.

At recent meetings of the Institution of Electrical Engineers, papers were read by Dr. Oliver Lodge and Mr. S. Evershed, describing methods of magnetic induction telegraphy, and containing the outlines of a system that seems to be far more possible of extension and infinitely more adaptable to long-distance work than the Hertz-wave methods recently and loudly exploited. Dr. Lodge's paper is of great length, and contains an outline description of a new method of operating magnetic induction signals, descriptions of experimental work and apparatus, and analytical discussion of the principles involved. In brief, the system he proposes is the use of the mutual magnetic induction between two horizontal coils of large size. It is, of course, evident that the horizontal disposition of these coils, which amounts, in effect, to placing them in the same plane, halves the possible mutual induction of the system ; but this arrangement introduces elements of great practical simplicity in the installation of such a system of signalling, and gives results that point toward the possibility of very-long-distance work with these means.

Through the coil at the sending station alternating currents of medium frequency are sent, in longer and shorter pulses as in the usual methods of telegraphy. At the receiving coil, which is similar to that used for sending, the circuit is "tuned" into syntony by the employment of reactive coils and condensers, across whose terminals a telephone, or some similar delicate receiver, is shunted. With this arrangement it is demonstrated that signals may be sent to any distance, provided enough copper and enough energy are employed in the sending coil. The calculation of the best proportions for the coils is not difficult, and the results are most striking. For example, it is calculated that, with a pair of coil circuits each about as large as England (say circles of 200 kilometers diameter) signals might be exchanged through a distance equal to the diameter of the earth. This assumes each coil to consist of one turn of copper wire about No. 0 gauge, and an applied voltage of 200 at a frequency of 1,000 cycles per second. Under these circumstances the current in the receiving coil would be about two microamperes, provided there were no absorption of the energy of the slow electro-magnetic waves by the conducting earth. This absorption, which is always in evidence, is, as yet, an entirely indeterminate quantity, but it is necessarily smaller with waves of comparatively low frequency, such as those just described, than with the high-frequency waves employed in radiant systems.

A number of most ingenious receiving instruments are described. Most of them are capable of being "tuned" into sensitiveness for a particular rate of vibration, thus becoming extremely sensitive for impulses of that wave-length and less so for accidental disturbances. Among these are tuning-fork telephones and sounding boards set in vibration by a moving coil telephone. From a point of a sounding board a stretched wire is led, the system of wire and board being tuned to responsiveness for the tone of the alternator employed. Upon the wire, and in circuit across the receiving condenser, is a very light coil in the field of a powerful magnet. This apparatus is said to be extremely sensitive and responsive.

Dr. Lodge's paper was evidently meant to be a general introduction to a further description of his recent work along this line of investigation. The later paper of Mr. Evershed is a description of the experiments conducted by himself and Mr. Cox along the same lines, and of the ingenious and beautiful instrument devised as a receiver. This is simply a vibrating loop of wire, adjusted to vibrate normally at the frequency of the sending circuit, and suspended in a strong magnetic field. The effects of even the faintest traces of current are, of course, cumulative in such an apparatus, and the vibrating loop may be employed either as a visual signal or to close a relay circuit. In this paper, also, a number of calculations are given for determining the size and power of loop circuits for this kind of space telegraphy.

Mr. Evershed's paper also describes some instruments and methods employed by himself and Mr. Cox in the British Post Office experiments in telegraphy to light-ships.

This work seems to be far the most important that has yet been done in the field of space telegraphy. It was soon evident that, whatever its possibilities for short-distance work, the ether-wave system of signalling could not be extended to really great ranges. If a simple and satisfactory system of long-distance signalling by magnetic waves, such as is proposed in these two papers, can be evolved, it seems likely that it will, in some measure at least, displace the direct-conduction methods using cables or long land lines. If, for example, it is possible to signal between the British Isles and the United States with circuits two hundred kilometers in diameter, the much lower cost of these, their simplicity and ease of repair, and the probability of a higher speed of working, should make cables obsolete in a short time. This is, probably, looking rather further ahead than the actual data advanced will warrant, but such a speculation is certainly attractive ; it may also be very profitable. At the very least the system set forth is worthy of elaborate experimental work on a large scale. Its value in time of war would be beyond computation.

English and American Machine Tools.

THE subject of the relative merits of English and American machine tools has been discussed in many journals from various points of view, but it still seems very much alive, and a recent editorial in the *Engineer*, together with subsequent correspondence, brings out some points with an emphasis which cannot be misunderstood.

The most active advance of American tools in England has taken place in connection with the cycle industry, and at the cycle shows one of the usual exhibits has been that of the special machines from the United States engaged in the rapid and automatic production of bicycle parts. The depression in the bicycle trade, however, has caused an extension of the American tools to general purposes, and at the Stanley show this year the tools and operations exhibited were mainly devoted to general work.

" Instead of having the tools in motion at work on hubs, bolts, screws, and other parts for cycles, it was noticeable that a large number of them were turning out the requisites of general engineering establishments,—bevel wheels in place of sprocket wheels, rivets or large screws in place of gibs and small screws, and so on."

The result has been the opening of the eyes of many English manufacturers to the wide capabilities of these and similar machines, and, with the removal of restrictions in the way of their use, automatic machine tools and the various automatic devices as applied to ordinary machines must come into general and permanent use.

The fact that this is the case need not be construed into a condemnation of English tools of the older type, for in many respects and for many purposes the older tools will continue to hold their own. It is when numbers of similar parts have to be made that the advantage of the automatic machine appears, and one of the especial features of the American system of manufacture is that all work, so far as possible, is systematised, in order to bring it within the range of automatic machine work, this essential feature being kept in view during the preparation of the designs.

Under these circumstances it is to be regretted that the English maker will not turn his attention to the design and manufacture of this class of machines.

"It was a fact which could have failed to strike but few observers that there were practically no tools of English manufacture exhibited at the Stanley Show, and at the National Show a firm which has always followed closely on American models had the best exhibit. Is it possible that English manufacturers cannot find time to devote some attention to this class of business, or is it that they still profess to despise American methods? If the latter is the cause, they would do well to undeceive themselves by an inspection of the American machines. It has been frequently stated that the imported article was weak and roughly made. A few years ago that was to a great extent true, but it is so no longer. American engineers do not stand still, and they have eagerly learned by experience. The consequence is that their tools are now-a-days at least as stoutly built as our own, and are as well finished, while in accessibility of their working parts, in ingenious automatic devices, in adaptation for rapid work, in convenience and handiness, they are far ahead of the productions of most British firms."

When the circumstances under which the tools of both countries were originally designed are considered, it appears most natural that such differences should appear. In England, until the question was settled by the termination of the engineers' strike, one man was not permitted to operate more than one machine, and machines which, by means of automatic contrivances, enabled skilled work to be done by unskilled men could have found no market. In the United States, on the contrary, such machines were eagerly welcomed from the first, and the idea that there was but a limited total amount of work in existence, to be parcelled out among the total number of workers, never found acceptance, experience having proved that the increased impetus which such machines give to industry results in wider opportunities for employment.

Now that the restrictions have been removed in England, such tools must undoubtedly come rapidly into use, and, if English tool builders will not furnish them, they must be purchased from abroad.

The matter is in the hands of the British manufacturer, and, in view of the clear statement of the case made by *The Engineer*, he cannot complain that he has not been duly warned.

Superheated Steam.

DURING the past few years there has been a decided revival in the use of superheated steam on the continent, but the practice has hardly extended yet to England; hence the paper of Mr. Paul Schou, read before the Northern Society of Engineers, and published in *Engineering*, giving the results of the latest continental practice, is especially worthy of notice.

Mr. Schou showed that the real reason why a higher economy than that now reached cannot be obtained with saturated steam is due to the nature of the saturated steam itself.

"The great drawback in using saturated steam as a driving power is that its range of temperature is very limited. On the one side, to raise the temperature of the steam we have a rapid increase of the steam pressure; and, on the other hand, we cannot lower the temperature of the steam below the temperature of the condenser.

"Quite apart, however, from these drawbacks, practice shows us that heat cannot be transformed into work without great losses. These losses take place principally in the steam cylinder, a part of the steam being condensed when coming into contact with the cylinder walls. The lower the mean temperature of the cylinder walls and the temperature of the steam leaving the cylinder, on the one side, as against the temperature of the admission steam, on the other side, the greater are the losses by internal condensation. The earlier the cut-off is, the more the internal losses increase, as the admission steam only heats a smaller portion of the cylincer walls,—that is, the mean temperature of the cylinder walls is lowered; consequently, a larger percentage of steam is condensed during the expansion period. Through this exchange of heat between the steam and the cylinder walls, 20 per cent. of the heat is lost without doing any work, even in the best existing engines, but this loss often amounts to 50 per cent. and more, in ordinary engines."

Various methods have been used to diminish these losses, those most generally in use being the steam jacket, multiple expansion, and a combination of both.

Another method consists of the superheating of the steam, so that the ratio of sensible heat to total heat may be increased, while at the same time a considerable reduction of temperature may occur in the cylinder before reaching the point where condensation commences. This method is one of the oldest, and had its origin in England; but, owing to difficulties in the operation of the superheating devices, and to the action upon the lubricants in the cylinder, it has fallen into disuse. However, with the improvements in mineral-oil lubricators of high flashing-point, as well as the general advance of constructive methods, these earlier difficulties have been overcome, and in the case of the Schmidt superheated steam engine some remarkable results have been obtained.

The construction of the Schmidt engine is peculiar, there being a high-pressure cylinder in the rear of a low-pressure cylinder, the piston of the former being a plunger formed on the disk piston of the latter. The steam acts first on the high-pressure piston, and then passes to the space in front of the low-pressure piston, this space acting as a receiver, whence the steam passes to the annular space behind the low-pressure piston. This peculiar arrangement of cylinders serves to a great extent to prevent the loss of heat through the cylinder walls, because the heat taken up by the high-pressure cylinder walls is not lost, but serves to heat the receiver; besides which there are constructive advantages.

An engine of this design, using steam superheated about 150° C., has been in use for several years on rolling-mill work, developing from 400 to 750 h. p., with a steam consumption of only 8 3-4 pounds of steam per i. h. p. Numerous other installations of engines of this type have been made, and in all cases the advantages of superheating are evident.

The Schmidt superheater consists of a series of coils of tubes between one and two inches in diameter, arranged in the flue, so as to be heated by the escaping gases from the boiler, though in some instances the superheating is effected by an independent furnace.

A very important feature in connection with superheated steam, and one which has not been always fully appreciated, is the fact that with superheated steam engines can be operated at light loads with far less loss than that which occurs when saturated steam is used. This is due to the fact that, with superheated steam, cylinder condensation, the losses by which are necessarily much greater at partial loads, is prevented. For this reason engines operated with superheated steam are especially adapted for electric power plants where widely-fluctuating loads are to be handled.

Warship Machinery During Action.

THE conditions of existence in the machinery spaces of a modern warship in action are probably about as difficult as may be found anywhere in the world. "From the very first the stokeholds and engine-rooms will be closed down, splinter bars and covers fitted, and air supplied by forced draught and ventilating fans," says *The Practical Engineer*. Water-tight and air-lock doors are closed, and all communication between the bridge and engine-room and stokeholds is carried on by means of voice-pipes and telegraphs. It is extremely unlikely that any message will be distinctly heard in an engine-room during heavy firing, and, in addition, the voice-pipes and signalling circuits of most warships are so exposed that they would not last long under a concentrated small-caliber fire. The electric circuits must be maintained during battle at all hazards, as upon these depend light in the interior of the ship, and, in many cases, motive power for gun-mounts and turrets. Provision must be made, though, for the use of hand-lamps, etc., in case the electric circuits fail. Air-compressing machinery must be kept running to supply torpedo tubes and pneumatic hoists. Unless the reserve feed tanks are full, the distilling apparatus must be kept going, while the duty of the feed pumps will be variable and severe throughout the action. The main engines will demand most attention, requiring probably two men at each set, one at the reversing engine and the other at the main stop and other valves. The fire and bilge pumps will require to be kept in operation during an engagement, and full pressure must be maintained on the fire mains to extinguish the fires likely to break out in various parts of the ship.

In cases where the main air pump is worked off the main engines, the loads on it will, of necessity, be heavy and severe, especially when starting at full speed after having been at rest for some time. In the main engine reducing-valves the fluctuations of the speed of steam will subject them to high and frequent changes of temperature, and hence of shape, possibly causing them to stick. The sticking of one of these valves would be a disastrous happening, and might place the ship in a very serious position. As cowl heads and windsails are likely to be thrown overboard or shot away, it is not impossible that smoke and powder fumes may be carried into the compartments below by the fans, —a very serious matter if the powder is of the smokeless, picric acid variety, as it would probably result in the suffocation of all hands below.

The boiler-room force also have a hard time in an action. On many ships there is a so-called protection of coal about their vitals. If the coal from the lower wing bunkers be exhausted, it will become necessary to trim from these upper protective coal spaces, thus exposing the trimmers, while, if a shell explodes in them, the fumes will fill the stokehold and probably set fire to the coal. If water is let into the coal by a shot, the bunker doors must be closed, and it is likely that the stability of the ship will be affected. As no ashes may be hoisted after the battle-hatches are down, except in ships fitted with hydraulic ash-ejectors, they may become a serious problem.

It will be seen from the foregoing that the engineer force aboard a warship have by no means an easy or safe berth in battle. It is probable that they are less safe, and certain that they are less comfortable, than their brethren behind the guns on the upper decks.

Long-Distance Electric Power Transmission.

THE literature of electricity possesses elements of the most diverse interest. Certain contributions to it have been of such value that important advances in civilization may be said to date from their appearance. The imagination has played its part, there being a variety of electrical literature best described as transcendental; and there have been facetious contributions, generally unintentionally so, but not the less amusing for that reason.

To the last category belongs Professor George Forbes's paper, lately read before the Society of Arts. It contains a proposition to transmit electrically energy generated at the Victoria Falls, on the Zambesi, to the Rand country,—in other words, to distances varying from 350 to 500 miles. It mentions, as easily and commercially possible, the lighting of Cairo from the first cataract of the Nile,—a distance of 400 miles. It even goes into details and gives figures, and, among other things, develops an entirely new idea in financing plants, proposing to use an indeterminate, but enormous, number of tons of copper wire, hung up in the heart of Africa, as a security upon which to borrow money at 4 per cent. The details are as amusing as ingenious.

It is assumed that, for a 400-mile transmission, all the power transmitted—say, 1,000 h. p.—can be sold at £50 per horse-power year. It is demonstrated that, under these circumstances, the plant will earn 40 per cent. annually above the mortgage on the copper, which, as the author ingenuously says, "may be taken away, if the company fails, and is an absolutely safe security." It is assumed that 20,000 volts will be used, that the operation-cost of the generating plant will be £20,000 per year, and that nothing will ever happen to necessitate repairs. The copper—3,600 tons of it in this case—is to be borrowed for an annual interest payment of 4 per cent. on its cost,—about £10,800 a year. It is easy to see that, if the annual income is £50,000, there will be enough profit to pay about 40 per cent. dividend on the cost of the electrical machinery.

It is a beautiful proposition, but it has its disadvantages. If such an arrangement could be made for the use of the copper, and if the line miraculously supported itself, like Mahomet's coffin, without poles, along a costless right of way and without attention, to a region where people are willing to pay £50 per year for one horsepower; and if there were no depreciation, no wind-storms, no lightning, no earthquakes; and if power cost nothing at the generating end,—this would be a truly magnificent scheme. It would pay handsomely—until somebody should build a railway and haul into its district concentrated power in the shape of coal. Doubtless such a railway could obtain its capital for rails on the same basis as that proposed above for borrowing copper.

The Ventilation of Tunnels.

THE ventilation of railway tunnels has been, for a long time, a somewhat serious problem. As these tunnels have grown in length the absolute necessity for some form of artificial ventilation, in most cases, has been apparent, and numerous plans have been suggested and adopted with more or less success.

At a meeting of the Institution of Civil Engineers, Mr. Francis Fox presented a paper dealing, in part, with this subject. Assuming that the presence of 20 parts of carbon dioxide in 10,000 parts of air is the maximum allowable percentage, he showed a simple rule for calculating the amount of air necessary to be pumped into a tunnel per minute to attain this dilution, if the headway and coal-burning rate of the locomotives is given. This rule has been used with success in calculating the ventilation of the Severn and Mersey tunnels. Referring to the Metropolitan railway tunnels, in London, the author stated that the proportion of carbon dioxide in their atmosphere was as much as 86 parts in 10,000.

The long alpine tunnels present graver problems. The Mont Cenis tunnel, which is 8½ miles long and 26 feet wide, has suffered at times from a lack of proper natural ventilation; the middle section of this tunnel being at a higher elevation than its ends. At present an antiquated system of ventilation is used, compressed air to the amount of 70 cubic meters per minute being injected at points one kilometer apart throughout the bore. The effects of bad ventilation in this case are not only the discomfort, and even danger, of the men working in the tunnel, but also a highly accelerated corrosion of the rails in it, as much as 300 tons of new rails being required to replace the annual waste from this cause.

The St. Gothard tunnel is about one mile longer than that of Mont Cenis, and of the same lateral dimensions, but, unlike it, is nearly level from end to end. Natural ventilation has sufficed for it until quite recently, when the adoption of briquette fuel on the locomotives required the installation of a forced ventilation system. The Saccardo method was used, this operating by blowing a large volume of air into the mouth of the tunnel,—this stream of air working on the injector principle to carry a further induced current of air along with it through the tunnel. In the Pracchia tunnel, on the line from Florence to Bologna, this system was recently installed and has worked with great satisfaction, the tunnel before its installation being dangerous to human life on account of accumulated gases. It is thought that the same system will be selected for use in the two parallel twelve-mile tunnels under the Simplon pass.

There is another solution of the tunnel ventilation problem, not mentioned in Mr. Fox's paper, that is both radical and certain,—the avoidance of smoke and the necessity for ventilation by the use of electric locomotives. This solution was adopted in Baltimore, with results so satisfactory that they should furnish a criterion for all future work along this line. In the Mont Cenis case, the deterioration of rails mentioned by the author is considerably more than sufficient to counterbalance the interest charges on an electric generating and conducting plant for the tunnel, and the locomotives; while the operation costs would be about the same in the two cases. It is to be hoped that the engineers of the new Simplon tunnel will recognise the homely fact that prevention is better than cure, and, instead of erecting a ventilating station, will build an electric plant and never allow their tunnel to be contaminated with the smoke of a locomotive.

The Bacterial Treatment of Sewage.

THE ENGINEERING MAGAZINE has already given space, both among its leading articles and in its review columns, to the increasingly important subject of the bacterial treatment of sewage, and now again there is occasion to give the matter further attention, in view of the recent paper by Mr. George Thudichum, presented before the Society of Engineers.

Mr. Thudichum shows that the experience which has been gained since the first introduction of the bacterial method has fully confirmed the correctness of the principles on which it is based, and he proceeds to show the conditions under which it may best be applied, and how, when necessary, it should be modified.

The three important questions which should be determined in any case are the available fall; the nature of the soil; and the possibility of the sewage containing ingredients which are hostile to microbial life. The available fall may decide whether the septic tank or the bacterial bed system shall be employed, and in gravitation schemes in which the total fall is less than four feet, the septic, or Exeter method possesses advantages, although pumping may be resorted to if economic reasons render it advisable. The nature of the soil may render the construction of bacterial beds advantageous, when, as is the case at Sutton, the clayey bottom renders the work very simple; but where the soil is light and porous the beds must be built on brick or concrete bottoms.

In regard to the character of the sewage, it has been apprehended that when it contains discharges from manufacturing establishments the bacterial action might be checked, but the experience of both Mr. Thudichum and Mr. Dibdin goes to show that such contaminated sewage can be successfully treated.

In a paper read before the Society of Chemical Industry it was shown that bacterial treatment was applicable to sewage containing considerable quantities of refuse liquors from many trades, including, effluents from tanneries, galvanising works, copper works, leather dressers, gas works, margarine factories, dairies, and distilleries. Taken as a whole, the experience of the last two years goes to prove that in the large majority of cases the manufacturing refuse which may be present in the sewage does not prevent the application of the principles of biological treatment throughout; whilst in cases in which preliminary precipitation or other treatment is necessary, the final purification can best be effected by means of the fine bacteria bed.

The Electrical Engineer.

IN discussing editorially a certain portion of Mr. Preece's inaugural address, *Engineering* calls attention to the use and meaning of the term electrical engineer in a manner which will bear examination, especially in view of the extending scope of the practice of many men already in that profession.

Mr. Preece, being himself an electrician, assumes that in the future every engineer will of necessity be an electrician, but if a knowledge of electrical science becomes a part of the ordinary equipment of the engineer, it will cease to be a distinguishing mark, and will no longer confer an appellation on its owner.

"Doubtless there will always be experts in electrical matters, just as there are in steam engines, but they will not be differentiated by name from the great mass of civil engineers. These must, in the future, be able to bring electrical science to bear on the problems offered to them for solution, or they will find the field of their operations slowly and steadily narrowing. The great object of all engineering is the replacement of manual labour by mechanical power, and yearly this will become more pronounced. In most cases energy can be more readily controlled and directed as electricity than under any other mode, and hence this is the form to which the engineer must most often turn. Electricity is merely a connecting-rod to convey power from the point at which it is generated to the point where it is to be utilised, but it is a rod of such exceeding elasticity that in many subjects it enlarges the capability of the engineer enormously, and indeed opens fresh regions to him."

Not only is electricity necessary to the engineer, however, but experience has shown that the mechanical problems are frequently the most important and difficult questions in connection with the installation of electrical plants. The very fact that electricity has entered the vast domain of power transmission and distribution renders it necessary that all the details of power generation and application must be understood and controlled by the engineer in charge of the work, and while it is true that the two branches of electrical and mechanical engineering are fast approaching each other, it is also true that the mechanical engineer is far more likely to absorb his electrical brother, than to be himself absorbed. Again and again it has been stated by practicing engineers having to do with electrical work that the actual electrical portion of the work forms often only about 10 per cent. of the whole, the remaining 90 per cent. being civil, mechanical, hydraulic and general. The great central power stations are in themselves vast aggregations of boilers, engines, pumps, conveying machinery, and all the multifarious accompaniments of piping, valves, fittings, and other details. In other cases, the power station includes dam and weir construction, with the installation of turbines and all the mechanical questions involved in the regulation and distribution or hydraulic power. These facts alone demand that the engineer in general charge of the design and installation of such plants should be a mechanical engineer of the broadest grasp, and while it is becoming more and more necessary that he should be thoroughly familiar with the science of electricity, that is only one more accomplishment which should be added to those which he already possesses.

As *Engineering* well says: "Electric science is becoming one of the elements in the mental equipment of the profession, and to be ignorant of it, whatever be the special line adopted, is to be half educated. On the other hand, it needs to be dinned in the ears of the public, especially of that portion which is debating what to do with its sons, that electricity itself offers only a restricted career, and that a knowledge of its laws does not fit a man to pose as an educated engineer. During the past ten years we have again and again insisted that the basis of engineering was general mechanical knowledge, and that a youth who studied only electrical machinery was not in the way of becoming an engineer—not even an electrical engineer."

"Electric hoists, electric cranes, electric driving of tools, electro-chemical operations, and many other examples might be adduced to demonstrate that the problems of the day can neither be solved by the electrician who is not an engineer, nor by the engineer who is ignorant of electricity. Young men in the profession, and many who are not young, have need to lay Mr. Preece's warning to heart before they find that they are dropping behind in the race for fame and wealth."

Water-Power Storage.

BEFORE the advent of electrical transmission it was generally thought impracticable to utilize any water powers except those which furnished a large volume and were in reasonably close proximity to commercial centres, where the power could be marketed to advantage. At the present time, however, it is found advantageous to harness even small streams, provided sufficient fall can be obtained; and in many instances streams comparatively insignificant in appearance are piped and led to impact or other wheels hundreds of feet below, and made most efficient sources of power.

In a recent issue of the *Elektrotechnischer Anzeiger*, Professor Intze, the recognized authority on the subject of storage reservoirs, discusses the manner in which many mountain streams whose flow is too irregular to furnish a satisfactory source of power may be impounded and regulated; and from experiences had in Switzerland and in Germany he details the elements which must be included in computing the cost of power obtained from such systems.

In order that satisfactory service may be obtained from an irregular supply of water, great care must be taken to secure accurate measurements both of the variations in flow and of the capacity of reservoir obtainable. In tropical countries there is usually a very definite division between the rainy and dry seasons, and it is necessary to provide a very large reservoir-capacity, but in central Europe experience has shown that with a moderate storage-capacity the flow may be regulated successfully, if proper care is given to the proportions of the plant.

The best method of studying any particular case is to plot the demand and supply as ordinates and abscissas, and construct the curve, the quantities being expressed in percentages of the mean annual flow. The maximum deficiency which may be expected may then be compared with the corresponding excess supply, and the requisite storage-capacity be deduced.

One of the earliest instances in Germany of a modern plant of such a system is that near Remschied, where the waters of the Eschbach, a small stream, are impounded and used for power and water-supply. This was planned in 1881, and since that time a number of such storage reservoirs have been constructed. Professor Intze gives the data of fourteen of these installations, with reservoirs ranging in capacity from 100,000 to 45,000,000 cubic metres, the latter being the reservoir for the 6,200-h. p. plant of the Urftthal, from which power is to be distributed from the waters of the Urft and the Ruhr to Mechernich, Düren, Eschweiler, Stolberg, Aachen, and other points, over distances of twenty to thirty kilometers.

Taking the experiences gained from these various installations, Professor Intze proceeds to compute the cost of power from a typical plant, assuming 7,200 working hours per year, and transmission distances ranging from twenty-five to thirty kilometers. Assuming an efficiency of 75 per cent., and allowing 10 per cent. for interest and depreciation, the cost of a horse power at the turbine shaft is found to be 32 marks per annum, while the cost of electrical conversion, transmission, and application is 47 marks, or a total of 79 marks per h. p. per annum. There is little doubt that, for a plant of corresponding size elsewhere, the cost could be kept within these figures.

There is every reason to believe that the interest which has been aroused in the development of hydraulic power is destined to increase, particularly in mountainous countries, such as Switzerland, Italy, and Norway, and the judicious use of carefully-proportioned storage reservoirs will render available for this purpose many streams otherwise too irregular to furnish satisfactory results.

The Influence of Heat on the Strength of Copper.

A VERY interesting series of tests of the strength of copper under various conditions has recently been conducted at the government testing laboratory at Berlin, by Professor Rudeloff, under the able supervision of Professor Martens; and a fully-illustrated report of the results is given in the *Mittheilungen aus den Königlichen Technischen Versuchsanstalten.*

The tests were undertaken to determine the following questions:

1. The influence of the chemical composition;
2. The relation between the chemical composition and the mechanical manipulation;
3. The permissible stress, both when annealed, and under various conditions of manipulation;
4. The strength of joints, either riveted, brazed, or both combined;
5. The influence of heat upon strength.

The most important portion of these tests was that which related to the influence of heat, since the extensive use of copper for fire-boxes, furnaces, boiler tubes, and high-pressure steam pipes renders it most desirable that the resistance should be determined under conditions similar to those of actual service.

By the use of the Martens 50-ton testing machine, in connection with special accessory apparatus for the purpose of maintaining the test-piece at a definite temperature, very reliable results were obtained, the delicate mirror extensometer enabling minute variations in length to be indicated very clearly.

The original report contains a great number of diagrams, plotted from the observed results, and showing plainly the weakening influence of heat. Without going too fully into details, for which the original paper must be consulted, some of the leading features of the tests may be given to show the general trend of the results.

For temperatures between — 20° C. and +20° C. the diagrams show very little change in the strength or elasticity, but for higher temperatures a very marked influence was apparent. From 100° C. to 200° C. the strength was not materially affected under moderate stresses, but under further warming the weakening action due to heat became very apparent, and above 200° C. the strength fell off rapidly.

When it is remembered that a temperature of 200° C., or 492° F., corresponds to about 225 pounds' steam pressure,—a force which is now frequently attained and even surpassed in marine practice,—the inadvisability of using copper-pipe connections under such conditions becomes apparent.

So far as the influence of chemical composition is concerned, it appears that further tests, covering a greater range of specimens, should be made. At the same time there is reason to believe that the presence of other metals—*i. e.*, very small percentages of tin, zinc, iron, nickel, lead, etc.—enables the specimen to resist the weakening action of heat, the purest specimens suffering the greatest diminution in strength. If this should be established, it would indicate that some carefully-tested composition might serve better for resisting pressure and heat than does the pure copper.

The tests also give valuable information concerning the influence which different mechanical manipulations have upon the strength of copper, including hot and cold rolling, hammering, annealing, etc.; and, coming from so reliable a source as the Berlin laboratory, these important investigations will doubtless be accepted by engineers everywhere as valuable contributions to our knowledge of the strength of one of the leading materials of construction.

American Industry as Viewed from Austria.

THE active entrance of American trade and the products of American industrial establishments into the business of the continent has led the American methods of production to be considered with some interest.

The causes of the development of American industries formed the subject of a long address delivered by Herr

Karl Wittgenstein before the Austrian Society of Engineers, and printed in the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines.*

Speaking from the standpoint of an Austrian, but possessed of a knowledge based on personal observation in various parts of the United States, Herr Wittgenstein gives some interesting information as to the conditions under which the competition between America and central Europe at present exists. Since Germany has made the greatest advances in industrial matters during recent years, he takes the German empire in comparison with the United States, and shows many interesting facts as to the different conditions surrounding labor and its products in the two countries.

Without going into the extensive statistical matter presented by Herr Wittgenstein, we may give the deductions which he makes, and upon which he bases his argument. In general, he shows that, taking into account many different lines of industry, the wage of the American workman is about double that of the German. Although the cost of living is greater in America, it is not proportionally so, in comparison with the higher earning-power. In America, on the contrary, food is less costly than in Germany, while clothing costs about the same, and dwellings alone are more expensive.

Although the American workman earns more than the German, this does not retard industrial enterprises, but, on the contrary, stimulates them, for these larger earnings are not hoarded, but spent in such a manner as to increase the internal trade of the country. But, if the American wages are higher than the German, the work is conducted in a far more intensive manner. Herr Wittgenstein aptly compares the American mechanic to the engineer of a fast express train, with mind and body strained to the utmost tension, while the German in many instances is more like the driver of the old post-coach. He affirms it to be the universal verdict of German mechanics who come to America that the pay is good, but the pressure of work far greater than at home.

After tabulating many statements of the relative growth of American and German industry, Herr Wittgenstein makes a brief historical *résumé* of the progress of industrial operations in America from 1600 down to the present time. Much of the early development was shown to be due to the efforts to exploit a new country as well as to the distance from the mother country and the necessity of reliance upon local resources. These conditions, however, also obtained in the Latin colonies; but in the latter the influence of individual initiative was subordinate to that of official and governmental control and direction. In the Anglo-Saxon colonies the spirit of individual freedom, sustained by the fundamental principles of English common law, enabled the individual characteristics of the race to develop almost to an unlimited extent, the contrast with the Latin colonies in this respect being especially a matter for comment.

Coming down to the present time, Herr Wittgenstein discusses the influence of education, showing the immense advantage possessed by the workman who has a good general education over the man who must always feel his inferiority in this respect. One of the greatest hindrances to industrial progress, he rightly says, is the abject European peasant, who, feeling his ignorance, stands with hat in hand before the proprietor, the parson, or the petty official, and is utterly without the stimulus to individual effort which can come only with the sense of civil equality.

Industry is not a determinate science, and cannot be subjected to mathematical laws. The successful man not only must possess technical and commercial ability, but must also have trained foresight into possible changes of policy or introduction of new methods, as well as that grasp of the entire industrial situation which can come only with speculative freedom of thought and action, such as exists nowhere else to such a degree as in America.

That such liberty and such methods often lead to undue speculation and to the precipitation of commercial crises is freely admitted, but such occurrences are not as great a drawback to progress as is the clog of governmental supervision and bureaucracy. In this respect Herr Wittgenstein differs wholly with the admirable presentation of the other side of the case by Mr. Magee in his paper on " America and Germany as Export Competitors," given elsewhere in this issue. In regard to the value of labor-saving machinery and methods he is fully in accord with Mr. Orcutt, who also discusses German and American industrial methods in this and other issues of this magazine; and it is only by a thoughtful comparison between these views, from various standpoints, of this many-sided subject that a true grasp of the present situation can be obtained.

Power-Development at the Iron Gates.

In the improvement of the navigation of the Danube at the Iron Gates the method adopted, fully described in these pages at the time, consisted in the canalisation of the stream by the side of the rapids, quiet channels of uniform slope being provided instead of the difficult and dangerous navigation of former times.

Even with these improvements the current in the canals is swift, and, in consequence, the ascent of the stream is slow and tedious, especially for heavily-laden vessels and tows. It has therefore been proposed to place locks at the lower end of the canal at the Iron Gates, thus not only overcoming the resistance of the current to upward navigation, but also providing a fall of 2.75 to 4.30 metres available for power, according to the condition of the river.

These proposed improvements are fully discussed, with profiles and plans, in an article in the *Zeitschrift des Vereines Deutscher Ingenieure* by Professor Hans Arnold, and the advantages of the plan are clearly set forth.

Since the opening of the canal to navigation on the occasion of the Hungarian millennial celebration in 1896, it has been evident that additional works must be undertaken to make the navigation of the Danube past the Iron Gates a commercial success.

The rapidity of the current in the canal offers a greater resistance than is desired, and the only way to diminish the current, other than the use of locks, is to prolong the canal up stream, dredging the bottom to reduce the slope, and incurring great expense and loss of much time.

The plans shown by Professor Arnold, however, not only provide for the avoidance of this expense by the use of locks, but also include the construction of a great power house to utilize the overflow water. This power house will be 522 metres long, divided into six sections, containing ten turbines of 400 h. p. each, upon vertical shafts carrying polyphase electric generators, the whole forming a plant capable of delivering from 20,000 to 24,000 h. p., according to the height of water.

The locks, which are to form an important portion of the improvements, will be 20 metres wide and 180 metres long, large enough to admit one steam tow boat and two large barges, and the elevation of the water-level in the canal will enable a depth of water of 3.1 metres to be maintained.

The completion of these important works, therefore, will not only render the navigation of the lower Danube far more practicable and profitable than has heretofore been possible, but also convert what has been the main cause of expense into an important source of revenue; moreover, it is by no means improbable that the presence of this large available power plant will develop industries which will in turn build up the river traffic.

Alternator Regulation.

The alternating current has met with continually-increasing application in the arts, largely on account of the simplicity of the apparatus concerned with its production and utilization, but many engineers still exhibit a decided preference for the direct current. They acknowledge the superiority of alternating currents for motor power and lighting purposes, but decry their universal use on account of three disadvantages possessed by alternating systems,—the troubles occasioned by capacity and self-induction in lines and apparatus, the necessity for synchronous speeds in alternators coupled in parallel, and the impossibility of connecting these machines in series.

A solution of these problems, remarkable both for ingenuity and simplicity, was proposed by M. Maurice Leblanc in a recent paper read before the Société Internationale des Electriciens. Referring to the three objections to the use of alternating currents, the author shows that the necessity for the practical elimination of wattless currents in alternating-current generators leads to a wasteful design in these machines, and an inefficient utilization of the materials of which they are constructed. In induction motors, also, the short air-gap, required for the double purpose of reducing magnetic leakage and keeping the power-factor high, is impracticable in large sizes. As to the question of synchronous driving, there is always a possibility of some form of "electro-mechanical resonance," or "hunting," on the part of one engine, impossible to foresee, and causing dangerous stresses in various parts of the system.

The Thury system of power-transmission by direct current at constant intensity of flow is limited in practice by difficulties of commutation. An alternating system of this character would be ideal, on account of both safety and simplicity, but it would absolutely require the possibility of connecting the generating machines in series.

The proposed system enables alternators to be compounded for constant voltage or constant current, to be connected in series or parallel, and to be constructed with a high armature self-induction, thus assuring stability of parallel operation, while at the same time permitting the greatest economy of material in their construction. The system is, briefly, as follows:

A special exciter is provided, having a speed and number of poles such that it runs synchronously with the alternator. Some form of mechanical connection between the two is requisite, the simplest being when both machines—generator and exciter—have the same number of poles and can be built upon the same shaft or directly coupled together.

In the exciter the rotating part consists of two similar Gramme rings, each wound with a number of regularly-spaced coils equal to that on the armature of the alternator, and bearing to one another the same phase relations as those between the coils of the principal machine, if this is polyphase. By means of slip rings and brushes the coils of one of these ring armatures are connected in series with the corresponding coils of the alternator, while, through a similar arrangement, the coils of the other ring armature are shunted around those of the alternator and the first ring.

Over the cores of the two Gramme rings is wound an ordinary direct-current winding connected to a commutator. On this are brushes, equal to the number of poles. The composite armature thus formed turns in a field consisting of two iron rings surrounding the cores of the two armature rings. These field rings are so proportionate that the magnetization of that one surrounding the series-connected part of the armature is far from saturation, while that of the other is strongly saturated when the machine works under normal conditions.

Over the two field rings is wound a continuous winding of as many turns as that on the direct-current layer of the double armature. To this are connected, through the field coils of the alternator, at points equally separated, leads from the commutator brushes. As the number of turns and current in this winding and that on the rotating parts of the machine connected to the commutator are equal, there is no magnetic flux produced by the rotation of the direct-current parts of the machine, the system being in equilibrium.

The alternating-current coils on the Gramme ring sections of the composite armature are so connected that they produce a rotating field, turning in a direction inverse to that of the mechanical rotation. Hence there is produced, by the alternating current, a stationary magnetic field, and, the armature reactions being entirely balanced out by the construction described above, the resultant voltage at the brushes and the magnetizing current supplied to the alternator fields depend only upon the output of the alternator and the setting of the exciter brushes.

Since, by this method, the field excitation of the alternator may be governed entirely by its output, it can be compounded either for constant current or constant voltage. By the addition of a "squirrel-cage" winding on the inner surface of the stationary rings, when the exciter is used with a single-phase machine, there is a tendency in each of the Gramme rings toward the production of two simultaneous rotary fields. That which turns in the direction of the mechanical rotation is destroyed by the "squirrel-cage," leaving the other, fixed in space, to operate as described above.

It is evident that these exciters will operate as synchronous motors, and can, therefore, be adapted to any alternator and set up in any convenient place.

Space does not permit a description of M. Leblanc's experimental verification of the value of this variety of excitation. It is evident that machines so equipped will lend themselves to a variety of uses, and that, despite the more costly construction of the exciter, the alternator may be built with a far higher armature self-induction and a consequently more economical use of materials.

But it is in the possibility of the use of such alternators as single-phase synchronous motors, and in the series connection of generators, that M. Leblanc's labors will probably bear the most valuable fruit. This method of excitation renders the Thury system possible with alternating currents, and may go a long way toward solving the difficult and fascinating problem presented by the adaptation of single-phase motors for traction purposes.

Telegraphing with Light and Electricity.

SEVERAL months ago there were noted in hese columns the experiments of Professor Zickler upon the use of the ultra-violet rays to produce an electric discharge at a istance, thus enabling intelligence to be ransmitted. The early experiments included but a small range of distance, and were intended rather to demonstrate the principle than to serve as a working system. A later communication in the *Elektrotechnische Zeitschrift* gives the results of further experiments.

The original trials demonstrated that, when the ultra-violet rays fall upon terminals which are just too far apart to permit an electrical discharge, the action of the light waves enable the discharge to occur, and hence, by use of screens of rock-crystal and glass, the interruption of the violet rays may be adapted into a means of communication.

In the later experiments a Schuckert projector was used, the source of light being an arc lamp operating at 47 volts with a current of 60 amperes, the carbons being so screened that only the reflected rays from the parabolic reflector are used, the direct rays being cut off. The receiver was made more sensitive to the action of the rays by allowing a less complete vacuum in the tube,—a vacuum of 340 mm. of mercury being used, instead of one of 200 mm., as in the former researches.

With this improved apparatus the distance over which intelligible communication could be maintained was increased from 50 metres to 1.3 kilometres, and the experience thus gained showed that further extension of the distance may be expected from additional improvements.

It is too early yet to speak definitely of the possibilities of this mode of communication, but there is reason to believe that for certain purposes this ingenious system is well adapted.

The New Bridge at Dusseldorf.

NEARLY two years ago there was given in these columns an account of the plans for the new bridge across the Rhine at Düsseldorf, and the peculiar conditions under which the work was undertaken were then stated at length. The completion of this important engineering work is now the occasion for several articles in the technical press, and from illustrated descriptions in the *Zeitschrift des Vereines Deutscher Ingenieure* and the *Oesterr. Monatsschrift für den Oeffentlichen Baudienst* some interesting features of the bridge are obtained.

In brief, the bridge has been constructed by a private corporation, and, in consideration of this construction, there has been granted to the company the right for an electric railway from the centre of the city, across the bridge, to Crefeld, some thirteen miles away, together with the collection of tolls on the bridge, and a title to more than nine hundred acres of reclaimed land on the left bank of the Rhine.

The structure itself is a noteworthy example of a type of bridge used in numerous recent cases in Germany, consisting of the braced arch with suspended roadway; at Düsseldorf there are two main spans of 594 feet each, with three smaller spans on the left bank, and one on the right, making a total length of more than two thousand feet. The construction of the masonry piers was begun in the summer of 1897, the pneumatic method being used, the foundations extending to a depth of about forty feet below the surface of the river.

The method adopted for the erection of the great arches presents some features of interest, and is well shown by photographs taken during the progress of the work. As it was required that the main channel of the Rhine should be kept unobstructed, it became necessary to construct the false works with a truss of 164 feet span over the channel, the remainder of the construction works being supported upon piles. The false works were carried up to a level above the highest point of the steel arches, and traveling gantry cranes were supported on the trackway thus provided. The facilities thus provided, together with the entire readiness of all material, made it possible to erect one of the great arches in the short time of six weeks, and thus permit the false works to be removed and the full waterway to be opened again.

One of the important points to be obtained by the construction of the bridge was the connection of Crefeld with Düsseldorf by electric tramway, and the improved communication thus secured between these two important industrial cities cannot fail to be of benefit to both. The construction company will be able to reclaim nearly one thousand acres of land on the left bank of the Rhine, all of which is to be improved and developed, while on the right bank the city of Düsseldorf is to construct a quay and promenade which will make it a rival to Cologne.

The total cost of the bridge, not including approaches and land damages, was 3,800,000 marks, or, including these additional charges, as well as interest, about 60,00,000 marks. As an engineering work the Düsseldorf bridge reflects great credit upon Professor Krohn, by whom the design and computations were made, and also upon the Gutehoffnungshütte, of Oberhausen, by whom the structural work was done and the erection conducted.

Water-Power Legislation in Italy.

THE development of the water powers of Italy by electrical means has been greatly hindered by a variety of singular legislative difficulties and the continuance of old laws, made before it was possible to generate power in one place and utilize it in another. The subject is treated very fully in an interesting report presented by Signore M. Vicarj and R. Pinna to a recent meeting of the Società Economiche, and printed in full in *l'Elettricità*.

The annual payment by Italians to foreign producers of coal is stated by these authors to amount to more than a hundred million lire. The country is full of streams of rapid descent, affording abundant water power. Of these a few have been developed, but the development does not keep pace with the growing requirements of Italian industries. In 1895 eighty-two concessions were made, for the development of 16,600 h. p.; in 1896, seventy-eight concessions, for 36,900 h. p.; and since then the demand for concessions has grown. In spite, however, of the increase of these authorizations for the exploitation of water powers, the annual consumption of coal in Italy has steadily mounted. It is to be remembered that no coal is mined in Italy, and that all that is used there comes from outside. In 1896 the importation amounted to 4,081,218 metric tons. The next year it increased to 4,259,646 tons. In addition to the increase in importation, the price of coal has also risen, and Italian engineers find themselves confronted with an absolute necessity of at once making use of the natural source of power afforded by the snows of the Apennines and the Alps.

But it is at this point that the difficulties begin. Each local district guards jealously its own supply of power water. The possibility of using the waters of one neighborhood for the development of power to be utilized in another place,—often to the actual detriment of the region in which it is generated—has caused an active opposition to most of the projects for water-power development. Concessions for the use of power are given by the district or provincial council, the right of private property in water-power not being recognized in Italy. When one of these concessions is sought, the promoters of the enterprise find themselves confronted with a variety of regulations and requirements,—features of ancient laws, still in force, but made with no reference to present conditions. If it is proposed to undertake the transmission of power by electricity to a distance, local opposition at once asserts itself, for the reason mentioned above. Further, the concessions, while limited to thirty years, are renewable indefinitely for similar periods, and this state of things has precipitated a warm discussion of the endless question of private versus governmental ownership and control of these works.

The New Reservoir at Madrid.

It is customary in many countries in Europe to construct roofed or covered reservoirs for the double purpose of preventing any contamination of the contained water and avoiding the heating of the water through contact with the air and sunshine. It has been the custom to build these reservoir roofs sufficiently strong to stand the weight of a thick layer of earth, which is used as a non-conducting covering. In the new reservoir under construction at Madrid, of which an account appears in *Revista de Obras Publicas*, a different system is adopted, which seems to promise decidedly better results.

The roofing consists of a double system of brick arches, one above the other, including between them an air space. These arches are supported by brick walls and pillars, which serve also to divide the reservoir into a large number of independent cells, and are very flat. Those of the lower roof are constructed of a single course of brick, laid in neat Portland cement mortar and given a surface dressing of the same. The upper roof arches are two courses thick, and constructed of the same materials. The span of these arches is about thirteen feet, their abutments being stout steel I-beams running from pillar to pillar.

The retaining walls and all the division walls and pillars are built of Madrid brick, not of very good quality, laid in Portland cement mortar and surfaced with concrete. Tests of the arches mentioned above showed that those of a single course of brick were able to sustain, without deformation or injury, loads of three tons per square metre of their upper surface.

This reservoir will be the largest of its type in existence, its capacity being 1,665,000 cubic feet, or more than twice as great as that of the Saint Cloud (Paris) covered reservoir. The work of construction, which was begun some time since and interrupted after the completion of the excavations, has been placed at contract, and the resulting cost of the finished work shows that this will be the least costly reservoir of the covered type in existence. The old reservoir at Madrid now holds the record for low cost, its construction having required an expense of only 17.76 pesetas per cubic metre of useful capacity. The new one will cost a little less than 13 pesetas per cubic metre.

Nothing is said as to the methods to be used in removing deposits of mud from this reservoir. Its construction has been hastened on account of the very muddy condition of the Madrid water-supply, especially in the spring, and it is supposed that this reservoir will act also as a settling basin. On account of the independence of the various divisions, however, it should be easy to keep it clean.

THE AMERICAN PRESS

Review of Leading Articles

Theatre-Sanitation.

THE subject of the sanitary arrangements of public buildings, always an important one, is especially so when it relates to theatres and other auditorium structures. For this reason much interest is attached to a paper upon the subject of theatre-sanitation, read before the American Public Health Association by Mr. Wm. Paul Gerhard, and published in *Sanitarian.*

Mr. Gerhard calls attention to the fact that the sanitation of places of amusement has been much neglected, mainly, no doubt, because the stay in such buildings is generally brief; but the large number of people frequently assembled in them renders the problems of warming, ventilation, and general sanitation peculiar in nature and treatment.

Under the peculiar conditions of theatre-construction there are few, if any, windows to the outer air which can be used for flushing, and, if no satisfactory ventilating system is installed, the audience is compelled to breathe, for several hours in succession, a noxious combination of the products of combustion due to gas illumination and of the respiration and perspiration of hundreds of people, some of them doubtless in need of a thorough washing, while many are clothed in ill smelling and dirty underclothes. There is small wonder that chemical analysis has shown the air in a theatre at the close of a performance to be more foul than the air of street sewers. Even when ventilating flues are included in the original construction of the building, or are added afterward, the incoming air is often drawn over filthy surfaces, and may be foully contaminated before it enters the building.

The dust problem is an important one in all theatres, since the dust on the stage is usually well stirred up by the scene-shifters between the acts, and floats out into the auditorium every time the curtain is raised, while the predominance of plush upholstering and heavy draperies adds to the difficulty of dislodging the settlings which accumulate.

Some of the worst abuses in that portion of the theatre behind the scenes arise from the use of old-fashioned buildings for modern spectacular performances, thus crowding the accommodations far beyond the original provision. This is especially true of dressing-room and toilet-room accommodations, to which, in all new structures, especial attention should be devoted.

Mr. Gerhard divides the subject into the departments of drainage, plumbing, water-supply, ventilation, lighting, and general sanitation. In regard to drainage, the principal problem, apart from the provision of ample capacity, lies in the fact that the so-called "under stage" is frequently below the sewer level, so that provision for pumping of drainage and for the prevention of entrance of sub-soil water must be made.

The plumbing of theatres should receive at least the same care given to that of other public buildings, while, as a matter of fact, it is usually badly done and worse cared for. Automatic flushing devices should always be used, as the public is generally very careless in handling the usual forms of apparatus. The main point emphasized is the provision of ample toilet accommodations, with plenty of water and air, using plain fittings of good quality, with every opportunity for access.

In regard to water-supply, two distinct systems are recommended, the fire protection being entirely separated from that for the plumbing system, and the arrangements otherwise not differing greatly from those of other public buildings.

The important subject of ventilation is discussed by Mr. Gerhard at length, and the question of keeping an auditorium comfortably warm, while changing the entire volume of air three or four times an hour is shown to be feasible as well as necessary.

The introduction of incandescent electric lighting marked the beginning of a new era in theatre-sanitation. Much of the vitiation of the air formerly came from the innumerable gas flames, both on the stage and in the audience; with the removal of this source of contamination the problem of ventilation has been immensely simplified. The fire risk has also been greatly reduced, so that three of the important features in theatre-sanitation have been most favorably affected by the advance made in lighting.

Speaking generally of the improvements which might be made in theatre-sanitation, Mr. Gerhard suggests more simple and thorough methods of cleaning the auditorium, including provision for scrubbing and sweeping every part. Leather-covered chairs are to be preferred to plush upholstery, while curtains and draperies are objectionable both because of the lodgment which they afford for dust and the assistance which they give to the spread of fire. There is really nothing about the whole subject which will not readily commend itself to the owner, manager, performer, or auditor, and the additional expense incurred by the introduction of proper sanitary appliances and care should readily be met by the increased popularity of the house in which it is known that such precautions have been taken.

The Question of Depreciation.

ONE of the most important points with which the modern industrial manager has to contend is the rate at which his plant depreciates. Formerly the terms "depreciation" and "wear and tear" were practically synonymous, but at the present time this is by no means the case. Many a machine which is actually good for many years of excellent service must be thrown out of service long before it is really worn out, simply because the owner recognizes that he cannot afford longer to use it in competition with rivals equipped with more modern machinery of far higher efficiency. This fact is now well recognized by manufacturers, in the United States at least, but seems even yet to be most unwillingly accepted by other lines of industry. Thus, in a paper on "The Coming Electric Railway," by S. H. Short, in *The Cosmopolitan*, the following passage occurs:

"Conservative railway men say that an insuperable obstacle in the way of substituting electricity for steam on the trunk line systems of the United States is the enormous sum—thousands of millions of money—now invested in steam railroad plants, which, it is assumed, would be rendered practically useless by such a change of motive power. There are thirty thousand steam locomotives, they say, in service today on American railroads. Putting their average cost at ten thousand dollars each, these steam locomotives represent three hundred million dollars of capital. It is impossible to conceive of the sale of three hundred millions worth of machinery as scrap iron."

Accepting this curious statement as the opinion of railway men, it goes to prove only that they have indeed been "conservative" in that they have neglected the signs of the times to a far greater extent than have the managers of other industrial enterprises. In the first place, the idea of considering the cost value of so rapidly depreciating machines as locomotives as a portion of capital is contrary to the truth; it is really only a question of time when any such asset as operative machinery must be sunk altogether, and this is a question which must be faced and solved, not dodged and evaded.

As a matter of fact, the problem is by no means new; on the contrary, it is very old. The introduction of "villainous saltpetre" into mediæval warfare, and the development of fire artillery, certainly rendered worthless untold values in the form of fortifications, armor, and weapons; the stage-coach superseded the post system, as the railway itself did the stage-coach. The horse-car has vanished before the electric trolley, and no feeble wail of depreciated values availed to suppress the clang of the motorman's gong. This idea of offering the loss of existing locomotives as a reason for the retention of steam locomotion reminds one forcibly of the opposition to the abolition of the court of chancery on the ground that to do so would deprive a large number of most estimable practitioners of a means of livelihood, and is so ludicrous as to make one wonder whether it is really offered seriously.

No one who considers the subject for a moment can deny that, should one of the great trunk lines equip its road with electricity, and thus, to use Mr. Short's own words, "reduce the time between New York and Chicago to ten hours and readjust the conditions of business and social life to a standard of one hundred and twenty-five miles an hour instead of forty," the competing railways would be compelled to scrap so much of their capital as is represented by steam locomotives. No considerations of cost could prevent such action ; it would merely be a question of existence.

Such being the case, and with so clear and obvious a warning as the past few years have presented, is it not important that a far more rapid rate of depreciation of all machinery liable to sudden replacement should be assumed?

The old idea that a machine with an apparent life, for example, of ten years, was properly depreciated by charging off one-tenth of its purchase price every year must to-day be replaced by a constant watchfulness of possible improvements in the line of work to which each machine belongs, and a prompt and rapid concentration of work upon any tool which may soon be superseded, with a view of making it earn the price of its inevitable replacement.

In this connection we may quote some emphatic statements from *Engineering*, which, although they have already been given in these columns, will bear repeating and emphasizing, especially in view of the revival of the idea that imaginary capital in the form of rapidly-depreciating machinery can be an obstacle to the march of improvement.

"Business is like a race; the entrance-money is only returned in the form of prizes. The man who drops out gets nothing back. Once a man has embarked his fortune in manufacturing, he can only regain it by being successful. He must constantly find more and more capital, and spend increasing sums on machinery; every year this necessity becomes more urgent."

"The machine that does not earn a profit is merely a useless encumbrance, however satisfactory it may be to look at, and it is actual economy to break it up with a sledge-hammer rather than to keep it filling up valuable space. This is a condition to which every machine comes in time,—often in a short time,—and, unless the owner has accumulated money to replace it by a better and a more expensive one, he has been living on his capital, whilst deluding himself with the idea that he was only spending his profits."

That this view of the case has not been taken by railroad men may be due to their "conservatism," but a better term for such *in*-action is recklessness.

Permanent Way for Railways.

It has developed, with advancing civilization, that permanent construction of works is the best safeguard against waste. In no department of construction is this fact more evident than in the building of road-bed and track for railways, for the destructive action of natural forces and of heavy passing loads requires an almost constant adjustment and repair to maintain these structures in operative order. It is hardly fair to call the American railway track of to-day a permanent way, because of the perishable nature of the wooden cross-ties and the weakness of spikes, etc., and also because of the upheavals and settlings due to the actions of frost and heavy loads.

In *Engineering News* Mr. J. W. Schaub has presented for consideration a system of track construction designed to render the "permanent way" of a railway really permanent. It consists, in effect, of a continuous reënforced concrete structure resting on a bed of Telford, and carrying lines of heavy rails tied together by long bolts passing through the upper part of the mass of concrete. This is brought up between the rails until its crowned top is flush with their upper surfaces. The whole structure will shed water away from its foundations, and will naturally result in an extremely rigid and permanent track. It will as certainly result in a very costly track, the author giving figures of cost at about $14,000 per mile without the rails; but, as the maintenance cost will be equally reduced and certain other expenses of operation lessened, an annual saving of nearly 4 per cent. on the cost of the reconstruction is also calculated.

In the editorial comment accompanying this article there is an extended discussion of the necessity for betterment of railway track systems from the standpoint of permanence and operative economy. The time has come when the two really large items of track maintenance are labor and tie-renewals. With the rapid diminution of forest areas the price of ties has steadily increased, and it cannot be very long before the conditions will necessitate either metallic ties or a return to the longitudinal support system. All recent experience with street railways, where the conditions of service are even heavier than on steam railways, has demonstrated that this method of construction possesses great advantages. At the best the cross-tie system was a make-shift; its retention to-day is a concession to conservatism.

In the American climate, with its severe winters, frost is the greatest enemy to alignment. No system which does not eliminate this difficulty can truly be called permanent. In the system described above the under parts of the structure are protected from water, and hence from the destructive action of frost, by the use of a very large mass of concrete. In an alternative system, proposed and illustrated in the editorial comment already referred to, the construction follows more closely that whose excellence has been proven by many street-railway lines. On the levelled and rolled surface is laid down a thin layer of sand. Upon this are placed concrete beams, of trapezoidal cross-section, into which are molded holding-down bolts of one-inch iron. These concrete beams are made up in sections about ten feet long, at any point convenient to proper stone or gravel, and their ends are provided with stout iron dowels and sockets. The rails are laid upon the upper surfaces of these beams, stout gage-bars, having holes for the reception of the holding-down bolts, maintaining them in perfect gage at all times. These gage-bars pass under the rail, embracing the outer end and lower surface of the flange, and are themselves held down by the bolts. Upon these bolts are also placed stout rail clips, so that, when the nut is in place, the rail, gage-bar, and concrete beam are held firmly together and in place. The space between the concrete beams is then filled with earth, crowned over at the top, and covered with a thin layer of asphalt. At the outer sides of the concrete base-beams a similar protection is applied, the result being a perfectly solid and permanent track, impervious to moisture and free from danger of upheaval through freezing or of settling through washing.

It should not be forgotten, in connection with this discussion, that the day is not far distant when the motive power of railways will be changed from steam to electricity. The probability and even imminence of this should not be lost sight of in any design for permanent way; otherwise the same difficulties of depreciation noticed so often elsewhere may be encountered. A track built solely with a view to present speeds and methods of train-propulsion may be found useless in a few years, even if its condition is excellent, in case it is not adapted to the electric-traction methods that will then be in vogue.

Conversion of the Washington Tramway System.

THE city of Washington has lately been the scene of some very interesting work, occasioned by the change from cable to electric traction on the principal street-railway lines. The history of the electric railway in Washington is an instructive instance of the appreciation which this system of tramway traction universally meets. Two years ago one of the street-railway lines there, then operated by horses, installed an elaborate electric-conduit system, but built its conduit so that it could be used for a cable, in case the electric system was found unsatisfactory. The immediate and remarkable success of this undertaking led the rival street-railway company to consider the question of changing its extensive system of cable roads to electric-conduit railways. A decision to do this was greatly accelerated by a fire which entirely destroyed the large central power house of the cable system, leaving these lines without motive power. Work was begun at once on the alterations, and carried on with the utmost speed until they were completed.

In a very complete description of the whole of this installation the *Electrical World* describes the methods used in transforming the cable conduit into an electrical subway. The cables and sheaves having been removed, the large porcelain insulators, from which the conductors are suspended, were bolted in place on the lower webs of the slot rails. This work necessitated the making of three new hand-holes in each 31½ feet of the track, the cable man-holes being at that distance apart. The space between the tracks was excavated, and a 24-duct conduit laid there for the copper feeders.

It is, of course, essential in an electric conduit to keep out moisture, or, at least, to prevent any water that may enter the open slot from trickling down the walls of the conduit and over the insulators. This requires that the slot rails be provided with lips to allow such water to drip harmlessly between the two conductor rails to the bottom of the conduit. The slot rails of the cable railway not being provided with these lips, but being otherwise in good condition and bedded in a first-class asphalt pavement, it was decided to rivet, onto the under sides of their upper flanges, small angle irons. This work, like the rest of the necessary drilling, riveting, etc., was perforce done by hand, there being no convenient source of power available.

Some years of wear had dropped the joints of the track rails, though these were in fairly good condition in other respects. While the other work was in progress, all the joints were brought into line, shims put in between the rail ends to tighten the joints, short rods put through the bolt holes, and masses of iron cast around the joint. As the heating of the rail ends caused them to bend upward to some extent, it was necessary to file the joints smooth by hand after the completion of the cast-welding process.

Another cable road belonging to the same company was subsequently converted, the work being made much more difficult by the fact that this line was in continuous operation, the cable running at all times except a few hours in the later part of the night.

An interesting consequence of the success of the original electric-conduit line and the converted lines is the decision by the Columbia Railway Company, now operating the last cable line left in Washington, to convert its system into an electric-conduit railway. This is to be done, notwithstanding the fact that the cable plant is practically new and in perfect working order, since it cannot compete with the electric systems.

Railway Construction in the United States.

As compared with the five preceding years the year 1898 showed a considerable and satisfactory increase of railway mileage in the United States. In 1892 there was laid down 4,192 miles of new track, this amount being somewhat less than that constructed in 1891, but more than has been added to the track mileage of the country in any year since. In 1897 there were only 1,880 miles constructed. Last year the new mileage amounted to 3,018 miles, with much more work begun, but retarded by the exceptionally bad weather of the fall and early winter.

The *Railway Age* gives an interesting tabulated statement of these additions. It appears that the extensions were constructed by 222 lines in no less than 45 States and territories, only five States—New Hampshire, Massachusetts, Rhode Island, Kansas, and Nevada—having built no new track. The greatest increase was in Minnesota, where 250 miles of new lines were laid.

The greatest activity has been in the southern and southwestern sections of the country, where fifteen States have built nearly one-half the total new mileage. There has been little new work in the New England States. On the Pacific coast nine States have built 430 miles, and the middle northern States have added to the total only 532 miles.

In addition to the above, there are several hundred miles of road on which track-laying is in progress, or is just beginning, and many hundred miles more are graded, on which track will not be laid until next spring. The indications for the coming year point to a season of great activity in railway-building, many important lines being projected in different parts of the country.

Compound Engines.

THE question of the most advantageous ratio between the areas of the cylinders of compound engines has of late been the subject of a somewhat animated discussion, mainly because of the wide departure from accepted practice advocated by Mr. George I. Rockwood, but the very excellent performance of those engines which have been constructed from his designs has gone far to support the correctness of his views, and hence a recent paper presented by him before the Providence Association of Mechanical Engineers, and published in the *Engineering Record* is of interest at this time.

The cylinder ratio formerly was, and still is, fixed within very narrow limits in all compound engines, whether built in the United States or in Europe. Continental manufacturers have favored a proportion varying from the ratio 1:2.75 to the ratio 1:3.25. English and American builders have generally adopted a slightly larger ratio, namely, one varying from the ratio 1:3 to the ratio 1:4. A common rule is to make the diameter of the low pressure cylinder two inches less than twice the diameter of the high pressure cylinder. These proportions have been adopted with the idea that they cause the minimum amount of " drop " in pressure between the two cylinders, it having been generally assumed that such " drop " is very wasteful.

Mr. Rockwood calls attention to the fact that there are two causes of " drop," one being intermediate expansion, due to the fact that the engine is so proportioned that more steam by volume leaves the receiver than is put into it per stroke, so that the receiver pressure is bound to be less than the pressure at release in the high-pressure cylinder. The other causes of " drop " are cylinder condensation and clearance in the low-pressure cylinder.

The usual practice in steam-engine design has been to use compounding with two cylinders and a ratio of about 1:3 for pressures up to about 115 pounds, using 12 to 15 expansions, and when high pressures are possible, and greater expansion desired, three or more cylinders have been employed.

Mr. Rockwood maintains, however, that as good results can be attained with a compound engine having cylinders of the same ratio as those of the high and low pressure cylinders of a triple-expansion engine as are possible when three cylinders are employed, and acting upon this conviction he has designed several compound engines with a cylinder ratio of about 1:7. These engines have given remarkably good results, being sold under a guarantee to use not over 12½ pounds of dry steam per i. h. p., and having in most cases surpassed this performance.

" The very best performance of any mill engine which has been tested by recognized and competent experts is one of this type running at the mills of the Grosvenor Dale Company, and tested by Mr. Barrus. The steam consumption was 11.89 pounds total per i. h. p. per hour, and the coal consumption was 1.18 pounds."

Mr. Rockwood puts himself on record as saying that he believes that a pumping engine of the largest size, working with practically no clearance, with steam at a boiler pressure of 180 pounds and a cylinder ratio of 1:8, would give a horse power on a consumption of less than 11 pounds of steam and a coal consumption of one pound per i. h. p. per hour.

The analysis which has been made by

Dr. Thurston on the Sibley College experimental engine confirms Mr. Rockwood's theory in so far as to show that the "drop" which occurs between the cylinders acts to improve the quality of the steam, showing that cylinder condensation does not depend directly and solely on the range of temperature of the steam. The extent of the surface exposed and the amount of "drop" have at least as much to do with it.

Wooden Stave Pipe.

As a consequence of the proposal to construct a pipe-line of over 300 miles in length in order to conduct water from the coast to the Coolgardie mining district in Western Australia, there has been a number of suggestions as to the best kind of pipe to be used for the purpose. The varieties proposed include thus far only metal pipe, and the commission recommended the use of straight riveted steel pipe, besides suggesting some experiments with the Ferguson pipe, a form of steel plate pipe with rivetless dovetailed longitudinal joint.

In a paper read before the Technical Society of the Pacific Coast by Mr. D. C. Henny, and published in the *Journal of the Association of Engineering Societies* the advantages of wooden stave pipe for the conveyance of water under pressure are set forth, and some very interesting data and information given.

From experience obtained on the Pacific coast and in the western United States the wooden pipe has done remarkably well in actual service. So far as losses of water from leakage and evaporation are concerned, measurements upon three wooden pipe lines have been made from which the actual losses can be determined. A test of 2½ miles of 18 inch pipe made at Astoria, Oregon, showed results which the author believes have never been surpassed by any other pipe construction of this class. The pipe was filled from the head works and the gate at the lower end of the section was closed and after the stand pipe had filled the head gate was closed.

"This gate was not absolutely tight, but permitted the passage of a little trickling stream, not exceeding one quart in a minute. The assistant engineer in charge of the works was much surprised on the following day to observe this same little trickling stream apparently undiminished in quantity, passing through the waste pipe at the end of the line."

Another test of 4.3 miles of 14 inch pipe near Los Angeles, in which the flow was carefully measured by weirs and gauges at both ends. As the measurements at both ends showed practically the same results, no leakage whatever was detected. The pressure in the Astoria pipe ranged from 0 to 80 feet, the thickness of the Douglas fir staves being 1⅜ inches, while in the case of the pipe at Los Angeles the pressure varied from 0 to 65 feet, and the thickness of the redwood staves was 1⅛ inches.

A very remarkable case is given of a 52 inch wooden stave pipe 968 feet in length in the form of an inverted siphon, built to carry the water of the Santa Ana Canal across Deep Canyon near Redlands, California. The lower portion of this pipe is subjected to a pressure of 165 feet, and the pipe was laid upon the surface of the ground the lower portion being carried across the stream at the bottom by means of a trestle. When filled with water and standing full the total loss of water was about 600 gallons per day, corresponding to about 0.057 gallons per square foot of exterior surface per day.

The limiting pressure which it is considered advisable to use with pipe of this sort is about 200 feet head, and experience has shown that in the case of redwood and Douglas fir there will be no loss from percolation when the pipe is buried, even at the highest pressure. As about 80 per cent. of the Coolgardie line requires a pressure of 200 feet, or less, there appears to be no objection to the stave pipe on the score of insufficient strength.

The question of the life of the pipe depends upon the exposure. When the pipe is laid upon the surface of the ground the exposure to the action of atmospheric changes results in a gradual external decay, causing a loosening of the bands, and when the decay reaches a depth where there is a permanent saturation there is a material increase in the loss from evaporation. Exposed lines in New England, built of pine, have lasted from 20 to 40 years, and a longer life might be expected of sound redwood.

When the pipe is buried, however, as is generally the case, the staves will remain water-soaked for their full thickness, and no decay will occur. The steel bolts and couplings will then be unprotected and the endurance of the pipe will be measured by that of the metal. Sufficient experience has not yet been had to determine the life of the metal under these conditions. The pitting which injures steel pipe would hardly be sufficient to impair the strength of the bands, and even if the metal was not fully protected against corrosion, it seems as if the stave pipe would last quite as long as steel pipe under the same conditions.

From the limited number of experiments which have been made upon carrying capacity it appears that the lower resistance to flow in the case of wooden pipe as compared with steel is a factor worthy of consideration, being equivalent to a reduction of 16 per cent. in head in the case of the Coolgardie line. Mr. Henny gives some useful computations of the value of " n " to be used in the Kutter formula for wooden stave pipe, and the whole paper is a valuable contribution to this branch of hydraulics.

The Work of the United States Coast Survey.

As long ago as 1807 the first appropriation was made by the United States government for a survey of the coast. In 1832 the Coast Survey was made a permanent department, and in 1843 its organization was revised and put upon the present basis. The work it has done, and its value, are so little known, that the paper of Mr. John F. Hayford in *Engineering News*, upon this subject possesses more than ordinary interest.

The whole coast of the United States has been accurately surveyed and charted, and an enormous number of off shore soundings have been made and plotted. The work upon the gulf-stream, its origin and mechanism, has done much toward a final understanding of this strange current. Tidal observations extending over many years and at a very great number of stations have furnished most complete and valuable data for tidal predictions. Magnetic observations, commenced originally for data for the correction of ship's compasses in harbor, have extended into an elaborate magnetic survey of the territory of the United States, unequalled for accuracy and extent.

But perhaps the most important work of the coast survey has been the measurement of two great arcs of the earth's surface. One of these, an oblique great-circle arc, extends from Calais, Me., to Fort Morgan, Ala., a distance of 1500 statute miles. The other, an arc of the 39th parallel of latitude, extends across the country and is no less than 2600 statute miles long. One of the proposed arcs will extend from the most southerly point of Texas to the Manitoba frontier, 23 degrees,—no other geodetic arc save that surveyed north and south through India being comparable to it in length.

"In that grandest of geographic undertakings, the measurement of the earth as a whole, another method of attack is by the use of the pendulum for the measurement of gravity at various points upon the earth's surface. The activity of the Coast and Geodetic Survey along this line may be inferred from the fact that its observers have occupied over 60 home stations and 28 foreign stations.

"The importance of a geodetic survey can not be properly judged by the number of points directly established by it. It bears the same relation to other surveys covering the same territory that the Supreme Court does to lower courts. Its results are of such a high degree of accuracy that it stands in the position of a court of last resort among surveys; it serves to prevent too great an accumulation of error in other surveys; to decide as to the right when two or more determinations by different surveys disagree; and to furnish indisputable points of departure for new surveys."

THE ENGINEERING INDEX

INTRODUCTORY

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20c. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m* a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill=Illustrated; W=Words; Anon=Anonymous.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. della Societa d. Ing. e d. Arch. Ital. Rome. *b-m.*
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Jour. *m.* London.
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg-und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am. Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S.A.R
Colliery Guardian. *w.* London.
Commerce. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, New York.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.

Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, O.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc of Engs and Surveyors. Peoria, Ill.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour N. E. Waterw. Assoc. *qr.* New London, Conn.
Journal Political Economy. *qr.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kans.
Locomotive. *m* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, O
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London.
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *qr.* Phila., Pa.
Proceedings of Central Railway Club.
Pro of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revista de Obras Publicas. *w.* Madrid.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerische Bauzeitung. *w.* Zürich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Düsseldorf.
State's Duty. *m.* St Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Terrestrial Magnetism. *qr.* Cincinnati, O.
The House Beautiful. *m.* Chicago, Ill.
The Mechanical Engineer. *w.* Manchester
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc Civil Engineers. *m.* New York.
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club. Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Locomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Belfast, Ireland.

The Architecture of Our Large Provincial Towns.—Belfast. Illustrations and description of the architecture, with something of the history, and general appearance. 2000 w. Builder—Nov. 19, 1898. No. 24311 A.

Brickwork.

The Bonding of Brickwork. Ernest Flagg. Discusses methods of bricklaying in the United States. Ill. 3300 w. Br Build—Dec., 1898. No. 24756 C.

Building Construction.

Column and Girder Construction in Dun Building, New York City. Illustrated description of steelwork in a 15-story building, having a unique pintle construction of Phœnix columns and a new method of horizontal quadrant girders over a corner entrance. 900 w. Eng Rec—Dec. 3, 1898. No. 24362.

Building Failure.

Failure of Building Foundation Piers. Illustrates and describes the partial failure of a new 8-story, 120×110 ft. commercial building in Brooklyn. 1100 w. Eng Rec—Dec. 17, 1898. No. 24606.

Church.

Constructing Roman Catholic Church at Quetta. Description of work with estimates of cost. Ill. 3500 w. Ind Engng—Nov. 26, 1898. No. 24787 D.

Design.

The Evolution of Structural Design. F. T. Llewellyn. Discusses especially frame design and the use of effective materials, thus overcoming the forces exerted by dead and live loads, wind pressure, &c., showing that development is due more to conditions and materials than to mechanical statics. Ill. 4000 w. Jour Assn of Engng Soc's—Nov , 1898. No. 24708 C.

Earthquake Districts.

Buildings in Earthquake Districts. On the contradictions of practice and anomalous conclusions drawn, due to the variety of shock which at different times and places may constitute an earthquake. 1200 w. Ind Engng—Nov. 26, 1898. No. 24785 D.

Flat-House.

An Example of a Modern Flat House. Illustrated description of a house with apartments renting for $18 to $20 a month. 1400 w. Eng Rec—Dec. 3, 1898. No. 24363.

Foundations.

Foundations. Frederick Baumann. Considers important points with special reference to Chicago soil. Loads, areas, settling, materials, piling, wells, &c. Ill. 4000 w. In Arch—Dec., 1898. No. 24623 D.

Important Problems in Construction. William W. Crehore. The present article is devoted to methods of building foundations. Ill. 3500 w. Br Build—Dec., 1898. No. 24753 C.

Pneumatic Caisson Foundations for a Residence. Illustrated description of the eight wooden pneumatic caissons necessary to support a house 80-ft. high on made land over an old water course; also describes a new air-lock. 3800 w. Eng Rec—Dec. 10, 1898. No. 24541.

Glass Construction.

A House of Glass. Jules Henrivaux. From the *Revue des Deux Mondes.* An account of the project to construct a house entirely of glass for the Paris exposition of 1900. 2200 w. Chau—Jan., 1899. No. 24759 C.

Grain Elevator.

Large Grain Elevator, Louisville, Ky. Illustrates and describes a 400,000-bushel steel elevator. 800 w. Eng Rec—Dec. 17, 1898. No. 24604.

Japan.

The Later Architecture of Japan. Ralph Adams Cram. An interesting illustrated account of Japanese architecture, noting the deviations and tracing the progress of changes to the present time. 4000 w. Arch Rev—Vol. V. No. VIII. No. 24668 F.

Materials.

Tradition and Material in Architecture. Alexander M'Gibbon. An abridgment, by the author, of a paper read before the Perth Archt. Assn. Calls attention to the influence of materials on architecture, also the influence of tradition, and size, and gives a brief forecast of the future, based on the experiences of the past. 4000 w. Builder—Nov. 19, 1898. No. 24312 A.

Oxford.

The Buildings at Oxford from an Engineer's Point of View. J. W. Parry. A very interesting description of some of the ancient buildings at Oxford, giving many details of construction and showing numerous engineering expedients resorted to by their builders before the day of steam or jacks. Among the buildings considered are Christ Church, the Cathedral, Pembroke College, S. Martin's Church Carfax, Lincoln, Exeter, Jesus, S. John's Colleges, S. Mary Magdalen, S. Michael's Church, Balliol, Trinity and Wadham Colleges, and many others. The structural details of the Radcliffe Library are especially interesting. 4400 w. Engineering Magazine—Jan., 1899 No. 24895 B.

School Building.

The New Commercial High School at Paris. (La Nouvelle Ecole Supérieure de Commerce à Paris.) Description, with illustrations and plans, of this building, intended to accommodate 300 students. 2000 w. Le Génie Civil—Dec. 10, 1898. No. 24866 D.

Spanish Architecture.

Modern Spanish Architecture in California. Caroline L. Overman. Illustrates some beautiful types found in Southern California, and comments on the climatic conditions which render this style especially appropriate. 800 w. House Beautiful—Dec., 1898. No. 24373.

Storage.

Cold Storage Rooms. W. H. Wakeman. Describes proper construction and insulation, with some reference to piping. Ill. 2000 w. Ice & Refrig—Dec., 1898. No. 24392 C.

Street Architecture.

London Street Studies. T. Raffles Davison. Illustrates and describes some of the best efforts, with critical comments. 2000 w. Brit Arch—Dec. 16, 1898. No 24791 A.

Suburban Residence.

Suburban Residence Built of Brick. Walter Cope. Illustrates and describes a house built at a cost of $10,000, arranged with special reference to convenience. 2000 w. Br Build—Dec., 1898. No. 24752 C.

Tall Buildings.

The Tallest of the Modern Office Buildings. Illustrated description of the Park Row Building, New York, with comments on the changes in the lower part of the city, and comparison with the Great Pyramid in height and bulk. 2500 w. Sci Am—Dec. 24, 1898. No. 24702.

Theatres.

Modern Opera Houses and Theatres. Edwin O. Sachs. Review of the third volume of Mr. Sachs' work on theatrical construction and stage equipment. It treats of the planning of various parts, the provision for service, the construction, lighting, warming, ventilation, water-supply, telegraphy, &c. Ill. 2000 w. Arch, Lond—Nov. 25, 1898. No. 24452 A.

Town Hall.

Victoria Town Hall and Theatre, Singapore. Perspective view with brief description. 500 w. Ind Engng—Nov. 12, 1898. No. 24635 D.

University Building.

The Mining and Chemistry Building of M'Gill University. Describes a very complete building recently opened and dedicated. 1500 w. Eng & Min Jour—Dec. 24, 1898. No. 24772.

HEATING AND VENTILATION.

Combined Heating.

Hot Water and Hot Air Heating Combined. From a pamphlet issued by Isaac A. Shepard & Co., Phila., called "Hints About Heating." Calls attention to things to be considered, and ways of overcoming difficulties. 2000 w. Met Work—Dec. 24, 1898. Serial. 1st part. No. 24705.

Eaves.

Melting Ice from Eaves of Flat Roofs. Considers different methods that have been tried and the degree of success attained. 600 w. Heat & Ven—Dec. 15, 1898. No. 24914.

Fan System.

Fan System of Heating and Ventilating the Central Telephone Building, Paris, France. Brief illustrated description of the apparatus and novel features, with an account of an unusual method of procuring fuel and attendance. 1000 w. Heat & Ven—Dec. 15, 1898. No. 24912.

Munich.

The Heating and Ventilating of the New Court House at Munich. (Die Heizung und Lüftung im Neuen Justiz-Gebäude in München.) A general description of this important work, presented before the Munich convention of the Society of Heating and Ventilating Engineers. 3500 w. Gesundheits Ingenieur—Nov. 15, 1898. No. 24817 B.

Natural Ventilation.

Natural Ventilation. (Ventilazione Naturale degli Ambienti.) D. Spataro. An exposition of Recknagel's theory and a discussion of the most suitable types of walls for dwelling houses. Illustrated. 5000 w. Annali d Soc d Ing e d Archit Ital—Sept.-Oct., 1898. No. 24874 E.

Residence.

Heating and Plumbing a House. Describes the heating system and plumbing system of the residence of A. C. Coburn, at New Britain, Conn., giving plans. 2000 w. Met Work—Dec. 10, 1898. No. 24502.

Hot-Water Heating of a Residence. Illustrated description of a heating system with new features in the connections. 400 w. Eng Rec—Dec. 17, 1898. No. 24607.

Schools.

System of School-House Ventilation at Lynn, Mass. Illustrated description of improvements at the Centre Street School. It is a system of jacketed stoves. 1000 w. Heat & Ven—Dec. 15, 1898. No. 24915.

The Heating and Ventilating of the Schoolhouse at Neuhausen by Use of Gas. (Gasofenheizungs und Luftungsanlage im Schulhause zu Neuhausen.) A paper before the Munich convention of Heating and Ventilating Engineers. Fuel gas, generated from coke, is used. 5000 w. Gesundheits Ingenieur—Nov. 30, 1898. No. 24818 B.

Ventilation and Heating of a New Brunswick School. Describes and illustrates a small school ventilated and heated on the indirect blower system, with double ducts and air mixing at the base of the flues. 900 w. Eng Rec—Dec. 10, 1898. No. 24542.

Temperature.

The Fall of Temperature of Warm Air in Metal Ducts. J. H. Kinealy. Discusses how the fall of temperature of air passing through a duct, under stated conditions, may be determined. 1500 w. Heat & Ven—Dec. 15, 1898. No. 24913.

PLUMBING AND GASFITTING.

Hospital.

Plumbing in the Long Island State Hospital. Illustrated description of the work in an asylum for 900 patients, with description of buildings. 2400 w. Eng Rec—Dec. 3, 1898. No. 24364.

Plumbing in the Long Island State Hospital. Illustrates and describes the arrangement of the kitchen and bath-house plumbing, which required special treatment because of the insane patients using it. 1100 w. Eng Rec—Dec. 24, 1898. No. 24734.

House Drains.

Ventilation of House Drains. A report by Dr. Unna, the municipal engineer of Cologne, on experiments made upon the necessity of fixing secondary ventilating pipes for house drains, and the consequent circulation of water and air in the same. Ill. 5000 w. Can Arch—Dec., 1898. No. 24691 C.

House Plumbing.

Hints on Modern House Plumbing. W. F. Taaffe. An effort to simplify the application of scientific truths to the work of the plumber. 3800 w. San Plumb—Dec. 15, 1898. Serial. 1st part. No. 24687.

Ordinance.

New Plumbing and Drainage Ordinance, Portland, Ore. A copy of the ordinance regulating the plumbing, ventilating and drainage of buildings. 3500 w. San Plumb—Dec. 15, 1898. No. 24688.

MISCELLANY.

Architecture.

The Position of Architecture Among the Fine Arts. Edwin T. Hall. Considers the definitions of architecture as given by various writers, and the relations of the fine arts to each other and to architecture. Gives interesting information concerning the development and of the correct principles of design. 10,000 w. Builder—Dec. 17, 1898. No. 24779 A.

Arts.

Arts and Crafts. H. Wilson. Read before the Architectural Assn., London. Reviews the progress from prehistoric times, noting their influence, and showing architecture to be a complex art; and traces the evolution to the present. Discussion follows. 11,000 w. Builder—Nov. 19, 1898. No. 24313 A.

Baluster Shafts.

Saxon Baluster Shafts. Drawings and description of characteristic examples. 2500 w. Builder—Dec. 3, 1898. No. 24560 A.

Building Laws.

Building By-laws and Their Administration. W. Henman. Read at meeting of the Royal Inst. of British Archts. A discussion of affairs outside of London, and the annoyances and irritations to architects in consequence of existing evils. Discussion. 2500 w. Builder—Dec. 17, 1898. No. 24778 A.

The London Building Act and the Official Supervision of Buildings. W. Weaver. Read at meeting of the Surveyors' Inst., London. Discusses the act and the manner in which it is enforced, also the desirability of adopting the system prevailing under the Public Health Act in the provincial towns of England. 6000 w. Builder—Dec. 17, 1898. No. 24780 A.

Competition.

Some Famous English Artists on Competition. J. P. P. Quotes the opinions of Ruskin, William Morris, Walter Crane and others, commenting on the views and giving the writer's opinions. 1800 w. Am Arch—Dec. 10, 1898. No. 24548.

English Cathedrals.

On the Comparative Value of Documentary and Architectural Evidence in Establishing the Chronology of the English Cathedrals. Francis Bond. The need of careful criticism of documentary evidence, and the need of comparison with the story told by the building. Also discussion. Ill. 13,500 w. Jour of Roy Inst of Brit Arch'ts—Nov. 26, 1898. No. 24696 B.

Fire Exposure.

The Exposure Fire in the Home Life Insurance Building, New York City. Describes the fireproof construction and the conditions existing, the progress of the fire, the damage, and the facts ascertained. 1800 w. Eng News—Dec. 8, 1898. No. 24501.

Fire Protection.

A Seventeen-Story Building Tested by Fire. T. Cusack. Observations on the lessons learned by the fire effect on the Home Life Insurance Building, New York. 1100 w. Br Build—Dec., 1898. No. 24754 C.

Radical Changes Necessary in Fire Extinction in New York City. Jean Wetmore. A discussion of the inadequateness of the present fire system to protect the high buildings, with suggestions for improvements. 2500 w. Elec Eng, N. Y.—Dec. 22, 1898. No. 24671.

Report on Home Life Building Fire, New York, Dec. 4, 1898. Charles J. Everett, Jr. Illustrates and describes the building and the damage, drawing conclusions from the facts stated. 2300 w. Br Build—Dec., 1898. No. 24755 C.

The Home Insurance Building Fire. Illustrated description of the effect of a violent exterior fire, and fires on several stories, on the structure of a 260-ft. office building, the examination being made before the fire was entirely extinguished. 3400 w. Eng Rec—Dec. 10, 1898. No. 24538.

The Need of Improved Methods for Extinguishing Fire in High Buildings. Editorial discussion of this subject in connection with the partial burning of the 16-story Home Life Insurance Building in New York. 2500 w. Eng News—Dec. 22, 1898. No. 24679.

The Protection of High Buildings. Views of prominent architects, firemen, and others on the best means of protecting from fire. 2000 w. Fire & Water—Dec. 17, 1898. No. 24653.

The Status of the Fireproof Building. Oscar Lowinson. Discusses questions of fireproof protection in connection with the destructive effects of the recent fire in the Home Life Building of New York. 1500 w. Arch & Build—Dec. 24, 1898. Serial. 1st part. No. 24-707.

Marble.

Marble Work. George H. Blagrove. The uses of marble in its relation to architecture are briefly discussed. 3000 w. Can Arch—Dec., 1898. No. 24690 C.

Metal-Work.

Metal-Work. T. Swaffield Brown. Read before the Sheffield Soc. of Archts. A discussion of the principles and processes of metal-work. Ill. 6400 w. Jour Roy Inst of Brit Archts—Nov. 26, 1898. No. 24697 B.

Moving Buildings.

Moving a Five Story Brick Block. Illustrated description of the moving of a 5-story 100×65 ft. brick block, weighing 3,000 tons, a distance of 110 ft. 1100 w. Eng Rec—Dec. 17, 1898. No. 24605.

Newark Priory.

Newark Priory, Surrey. Gives ground plan of the remains, some sketches, and notes on its architectural features. Ill. 1500 w. Builder—Nov. 26, 1898. No. 24451 A.

Steel Framework.

The Use of Steel in Buildings. Edward Wood. Read before the Manchester, Eng., Assn. of Engs. A discussion of the advantages of steel as a material for the framework of buildings. 4000 w. Mech Wld—Dec. 2, 1898. No. 24554 A.

Venice.

Venice. Mowbray A. Green. Read before the Bristol Soc. of Archts. Descriptions of the architecture, with historical review. 7500 w. Builder—Dec. 10, 1898. No. 24725 A.

Windows.

Oriel and Bay Windows. Paul Waterhouse. Read at meeting of the Archt's. Assn., London. Considers the objects for which these windows are built, and the various treatments, successful and otherwise. 8000 w. Arch, Lond—Dec. 2, 1898. No. 24557 A.

The Making of Stained Glass Windows. Theodore Dreiser. An illustrated description of American work with comments on its excellence. 3500 w. Cos—Jan., 1899. No. 24661.

Wind Pressures.

Wind Pressures on Surfaces of Different Areas. C. Baillargé. An explanation of the difference in unit wind-pressures registered simultaneously on different areas. 800 w. Eng Rec—Dec. 3, 1898. No. 24361.

CIVIL ENGINEERING.

BRIDGES.

Alexander III.

False Works and Traveling Bridge for construction of the Alexander III. Bridge. (Notes sur la Construction du Pont Alexandre III. Exécution des Travaux Préparatoires. Pont Roulant de Montage.) This very elaborate description of the traveling bridge false-work for the steel arch of the Alexander III bridge is really an essay upon the continuous girder, and both the text and the 4 large plates of illustrations contain much valuable information. 11,000 w. Ann des Ponts et Chaussées—3e. trimestre, 1898. No. 24884 E+F.

The Alexander III. Bridge at Paris. (Le Pont Alexandre III. sur la Seine.) E. Rouyer. An elaborately illustrated article on the construction of the abutments for this bridge, including a description of the caissons, concrete work, and superstructures. A fine plate giving a general elevation of the finished bridge accompanies the paper. 5000 w. Le Génie Civil—Nov. 19, 1898. No. 24862 D.

Arches.

Masonry Bridges Hinged at the Springings and the Key. (Ponts en Maçonnerie Articulés aux Naissances et à la Clef.) M. Bourdelles. This is an able review of the subject. Beginning with an historical introduction, it discusses triple-hinged arches as compared with those made solid at the springings, gives details of construction of vaults, arches and bridges of triple-hinging, and ends with a description of the general method of calculating the curve of pressures by M. Jean Résal. It is illustrated with many diagrams. 12,000 w. Ann des Ponts et Chausées—3e trimestre, 1898. No. 24880 E+F.

Berne.

The Kornhaus Bridge at Berne. (Die Kornhaus-Brücke zu Bern.) A very fully illustrated account of this fine new bridge across the valley of the Aar. The main arch has a span of 115 metres. 7500 w. 1 plate. Zeitschr d Ver Deutscher Ing.—Nov. 19, 1898. No. 24803 D.

The Kornhaus Bridge at Berne. (Le Pont du Kornhaus, à Berne.) Henry Martin. An elaborately illustrated detailed description of this important steel arch bridge. Two articles. 8000 w. Le Génie Civil—Nov. 26 and Dec. 3, 1898. No. 24864 each D.

Bridge Accident.

Destruction of a City Bridge by a Train. Illustrated description of the destruction of a highway bridge in St. Paul, Minn., by a train passing below it. 700 w. Eng Rec—Dec. 24, 1898. No. 24729.

Brooklyn Bridge.

The Safety of the Brooklyn Bridge. Editorial discussion of the condition of the bridge, urging such reconstruction as will secure absolute safety. 1800 w. R R Gaz—Dec. 16, 1898. No. 24594.

Caissons.

Brooklyn Caissons, New East River Bridge. Illustrated description of the design, construction and use of two wooden caissons, 63×79 ft. in plan, and 53 and 39 ft. high. 2300 w. Eng Rec—Dec. 17, 1898. Serial. 1st part. No. 24598.

Improvements in Pneumatic Caissons, Air Locks and Shafts. Illustrates and describes improvements made by John F. O'Rourke in the caisson shaft and the air lock. 1000 w. R R Gaz—Dec. 9, 1898. No. 24487.

Cantilever.

Bridge 1680 Metres Long over the Red River (China). (Pont de 1680 Mètres d'Ouverture sur le Fleuve Rouge.) M. Bricka. This cantilever bridge is to be built on the railway line between

Hanoi and the frontiers of China. It will have 19 spans, the longest of 348 feet. Description illustrated with one plate. 1600 w. Ann des Ponts et Chaussées—3e. Trimestre, 1898. No. 24886 E + F.

The New Bridge Across the Rhine at Düsseldorf. (Die Neue Rheinbrücke bei Düsseldorf.) A general description of the work, with data as to cost, and some account of the electric tramway over the bridge from Düsseldorf to Krefeld. 2000 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1898. No. 24814 D.

The New Bridge over the Rhine at Düsseldorf. (Die Neue Rheinbrücke bei Düsseldorf.) A brief account of the completion of this fine new braced arch bridge, with illustrations showing the method of erection. 1000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Nov. 19, 1898. No. 24805 D.

Harlem Bridge.

Bridge Over the Harlem River. An illustrated description of the bridge which carries the N. Y. C. & H. R. R. R. over the Harlem River, at New York. 1500 w. Engng—Dec. 9, 1898. No. 24638 A.

Highway Bridges.

Highway Bridge Building. Albert W. Buel. A discussion of the character of highway bridges and of methods to improve this work. 4200 w. Eng Rec—Dec. 24, 1898. No. 24732.

Piers.

Masonry Pier Moved by Ice and Replaced. R. W. Leonard. From a paper read before the Canadian Soc. of Civ. Engs. Describes the replacing of an unfinished pier, moved out of position by the ice. 800 w. Can Eng—Dec., 1898. No. 24550.

St. Louis, Mo.

Franklin Bridge, Forest Park, St. Louis, Mo. Illustrated description of a 60-ft. arch of concrete and steel. 600 w. Eng Rec—Dec. 10, 1898. No. 24539.

Stresses.

Moving Load Stresses in Bridge Structures. Points out the necessity of experiments on the deformation of bridges under live loads for further advance in the application of the theory of fatigue in metals to practical design. 900 w. Eng Rec—Dec. 3, 1898. No. 24357.

Suspension Bridges.

New York and Brooklyn Bridge. Report of C. C. Martin, chief engineer and superintendent, on matters connected with the bridge. Considers the bridge as safe as it ever was. 1200 w. R R Gaz—Dec. 9, 1898 No. 24486.

New York and Brooklyn Bridge. W. Hildenbrand. A letter commenting on the reports made concerning the strength of the bridge, and suggesting a means of so strengthening it as nearly to double its capacity. 1000 w. R R Gaz —Dec. 9, 1898. No. 24484.

Testing.

On the Uselessness of the Testing of Iron Bridges by the Method of Loads. From the *Organ für die Fortschritte des Eisenbahnwesens.* Shows the tests to be defective and not a warranty of safety. 900 w. Ind Engng—Nov. 26, 1898. No. 24786 D.

CANALS, RIVERS AND HARBORS.

Barry Dock.

New Works at Barry Dock. An account of a visit of members of the British Assn., to these docks, with information from the paper of R. C. H. Davison, presented at the recent meeting at Bristol. Ill. 1800 w. Engr, Lond—Dec. 2, 1898. Serial. 1st part. No. 24530 A.

Canal Traction.

Electrical Canal Traction. The first of a series of articles aiming to present a résumé of the salient points given in the *Bulletin of the Assn. of Elec. Engs. of Liege* for May, 1898. The writer of the original paper was Mr. Van der Wallen. 2500 w. Elec Rev, Lond—Dec. 9, 1898. Serial. 1st part. No. 24632 A.

Chicago Canal.

The Progress of the Chicago Main Drainage Channel. An abstract of the report of William Boldenweck, President of the Board, outlining the litigation and decision which has caused so much delay of the work. 2500 w. Eng News —Dec. 15, 1898. No. 24589.

Dam.

A Great California Dam. Enos Brown. Illustrates and describes the construction of the Crystal Springs dam. 1300 w. Sci Am—Dec. 17, 1898. No. 24573.

The Castlewood Dam. A. M. Welles. Illustrated description of a dam of loose rocks faced with cement mortar masonry, built acros, a torrential stream near Denver. 2400 w. Eng Rec.—Dec. 24, 1898. No. 24728.

Danube.

The Navigation of the Danube between Stenka and the Iron Gates. (Die Schiffbarkeit der Regulirten Donau-Katarakte Zwischen Stenka und dem Eisernen Thor.) Hans Arnold. An illustrated account of the operation of the canalized portion of the Danube at the Iron Gates, together with a description of the proposed utilization of the water power. 6000 w Zeitschr d Ver Deutscher Ing—Dec. 10, 1898. No. 24810 D.

Dredging.

Dredging Machine for the French Government. General view, with side elevation, and plan showing general arrangement, with description and report of trials. 1200 w. Engng—Dec. 2, 1898. No. 24525 A.

The Improvement of Tidal Channels by Pump Dredging. W. H. Wheeler. Read at the International Congress on Navigation, at Brussels. Gives examples showing that increased depth can be obtained at a reasonable cost, and that these channels, if due consideration is given to the direction of the tidal currents, will maintain themselves. 4500 w. Engr, Lond—Dec. 2, 1898. No. 24535 A.

Earth Slips.

Earth Slips on the Jordan. Level Marl Beds of the Erie Canal. George A. Morris. States the conditions that caused the earth slips and gives illustrated description of methods adopted and the difficulties encountered. 2000 w. Eng News—Dec. 1, 1898. No. 24323.

Floods.

The High Water Catastrophes of the Year 1897. (Ueber Hochwasserverheerungen im Jahre 1897). Ferdinand Wang. A review of the floods in mountain-torrents in Austro-Hungary, with a discussion of methods of regulation and control of such streams. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1898. No. 24815 D.

Interoceanic Canals.

Interoceanic Canal Problems. Brief editorial review of the rights guaranteed the U. S. in any canal that may be built at Panama, and of matters relating to the Nicaragua canal. 1500 w. Harper's Wk—Dec. 24, 1898. No. 24682.

The Nicaragua and Panama Canals. Editorial discussion of these enterprises and their relations. 1600 w. R R Gaz—Dec. 23, 1898. No. 24719.

Lining.

Lining of the Marne-Saone Canal. (Etanchement du Canal de la Marne à la Saone). Gustave Cadart. Detailed illustrated description of methods used in lining a leaky canal in calcareous earth. The best results were obtained from thin layers of concrete made of lime and the sandy gravel of the neighborhood, though many other methods were used successfully. 14,000 w. Ann des Ponts et Chaussees—3e trimestre, 1898. No. 24881 E+F.

Massena Canal.

Methods of Work on the St. Lawrence Power Co.'s Water Power Canal Near Massena, N. Y. Illustrates and describes one of the most interesting pieces of canal work now in progress in the United States. 2800 w. Eng News—Dec. 15, 1898. No. 24588.

Nicaragua Canal.

Advantages of the Nicaragua Canal. A. S. Crowninshield. A résumé of isthmus canal projects, with a statement of the advantages, feasibility and costs, the value to the Pacific coast and Gulf states, uses in war, &c., &c. Map. 6000 w. Century Mag—Jan., 1899. No. 24799 D.

Plain Words About the Morgan Bill for Purchasing the Nicaragua Canal Concession. Editorial reviewing briefly the recent history of the enterprise and explaining the present situation, giving reasons why the Morgan bill should not be passed. 3000 w. Eng News—Dec. 15, 1898. No. 24590.

The Latest Aspects of the Nicaragua Canal Project. Corry M. Stadden. Reviews the history of the project, the propositions that have been before Congress for its construction, the opposition, and the present situation. 5000 w. N Am Rev—Dec., 1898. No. 24387 D.

The Nicaragua Canal. (Der Nicaragua Canal.) A discussion by Herr H. Claus, of the isthmian canal question from a German point of view, with reference to the papers of Messrs. Haupt and Nimmo in the Engineering Magazine. 2500 w. Glaser's Annalen—Dec. 15, 1898. No. 24822 D.

Russia.

From The Baltic to the Black Sea. The Maritime Canal from Riga to Kherson. (De la Baltique à la Mer Noire. Le Canal Maritime de Riga à Kherson.) Georges Leugny. A fully illustrated description of this important work, which is intended to make an all-Russian outlet for the Black sea. The canal will have a total length of 1600 kilometers. 6000 w. La Revue Technique—Nov. 25, 1898. No. 24857 D.

Ship Canals.

Equipment, Management and Economic Influence of the Ship Canal. W. Henry Hunter. A handsomely illustrated article, taking as its text the Manchester ship canal. It shows the enormous traffic that has resulted from the opening of this water-way and the great increase in the trade of Manchester flowing from it, and states that, to-day, the canal is worth £1,000,000 annually to that city. In more general terms the author deals with the broader question of the economic influence of canals, which by stimulating competition in the carrying industry produce progress and aid development. 2800 w. Engineering Magazine—Jan., 1899. No. 24894 B.

The Lake Erie and Ohio Ship Canal. Harold Allen. Considers the general advantages of a waterway in this section, and the plans of a route recently advocated. 2400 w. Yale Sci M—Nov., 1898. No. 24421 C.

The Ship Canal of Bruges, Belgium. Abstract of description given in a pamphlet issued by the company to whom the contract was let. Ill. 900 w. Eng News—Dec. 22, 1898. No. 24680.

Suez.

Tides in the Suez Canal. (Etude du Régime de la Marée dans le Canal de Suez). M. Bourdelles. A very complete study of the conditions determining the movement of tides in narrow channels, with a new hypothesis to account for certain anomalies in the observed tidal movements in the canal. Illustrated. 4000 w. Ann des Ponts et Chaussées—3e. trimestre, 1898. No. 24879 E+F.

Tiber.

The Works on the Tiber. (Les Travaux du Tibre.) M. Ronna. A second paper upon the improvement works on the Tiber, describing the bridges, embankments and other works executed from 1870 down to the present time. A very complete and valuable paper, fully illustrated. 30,000 w. Bulletin de la Société d'Encour—Nov., 1898. No. 24828 G.

IRRIGATION.

Ground Water.

The Flow of Ground Water. A statement of the sub-surface flow of water in the semi arid regions. 700 w. Eng Rec—Dec. 24, 1898. No. 24730.

MISCELLANY.

Beams.

The Action of Continuous Beams and Girders in Structural Work. (Ueber den Einfluss der Kontinuität der Balken und Trager im Hochbau.) A mathematical treatment giving formulas from which tables are computed for various arrangements of supports. Two articles. 2500 w. Deutsche Bauzeitung—Nov. 26, 30, 1898. No. 24832 each B.

The Moment of Inertia of Built-up Beams. E. A. Dixon. An explanation of a method for finding the moment of inertia. 1500 w. Am Mach—Dec. 15, 1898. No. 24622.

Cement.

Experiments upon the Strength and Elasticity of Portland Cements. (Expériences faites sur la Résistance et l'Elasticité de Ciments Portland.) M. de Joly. These experiments were carried out for the French lighthouse service to attain data for the construction for concrete towers. They were made on samples of neat cement, sand mortar, and concrete, and included tension, shearing and pounding. 8500 w. 1 plate. Ann des Ponts et Chaussées—3e. Trimestre, 1898. No. 24883 E+F.

The Effect of Frost on Portland Cement. Review of important experiments at the municipal cold-storage plant of Manchester, England. 1800 w. Eng Rec—Dec. 24, 1898. No. 24731.

Cement Kilns.

The American Rotary Kiln Process for Portland Cement. F. H. Lewis. Illustrated history of the process. 3300 w. Eng Rec—Dec. 17, 1898. No. 24597.

Engineering Profession.

The Work of the Engineer. Editorial on the influence of the professional work on the engineer's character. 1500 w. Eng Rec—Dec. 3, 1898. No. 24356.

Engineering Schemes.

Engineering Schemes in Parliament. Editorial discussion of the private bills for consideration in the British parliament. The present article considers the railway schemes. 4000 w. Engng—Nov. 25, 1898. No. 24431 A.

Engineering Schemes in Parliament. Editorial discussion of private bills before the British parliament. The present article treats of plans of the smaller railway companies, with some applications for light railways. 3000 w. Engng—Dec. 2, 1898. No. 24526 A.

Foundations.

A New Air Lock and Cylindrical Wooden Pneumatic Caisson for Foundations. Illustrates and describes the use of the caissons, with improvements designed by John F. O'Rourke, in laying the foundations of a residence for Mrs. Elliott F. Shepard, on 62d St., near Madison Ave., New York. Also notes other interesting features of the construction. 1800 w. Eng News—Dec. 8, 1898. No. 24500.

Framework.

Notes on the Computation of Some Special Forms of Framework. (Beitrag zur Berechnung einiger Besonderer Sprengwerksformen.) G. Mantel. A graphical and analytical examination of certain forms of framed structures. Three articles. 5000 w. Schweizerische Bauzeitung—Nov. 12, 19, Dec. 3, 1898. No. 24830 each B.

Geodetic Survey.

The Geographic Work of the Coast and Geodetic Survey. John F. Hayford. Describes the work carried on, and the value of the information furnished. Plate. 3700 w. Eng News—Dec. 1, 1898. No. 24326.

Highways.

Ancient and Modern Highways. Charles Livy Whittle. An interesting illustrated review of the progress in road making among various nations, and from earliest times. 6800 w. States Duty—Nov., 1898. No. 24304.

The Surfacing of Roads, from the Wearing, Hygienic and Economic Points of View. (Delle Pavimentazioni Stradali sotto l'Aspetto della Viabilità, dell'Igiene e dell'Economia.) Report to the Società degli Inginieri e degli Architetti Italiani by a committee. It contains an interesting history of road-making and data of cost and wearing qualities of asphalt, wood blocks, various kinds of stone pavements, macadam and telford roads. Serial. 1st part. 7000 w. Annali d Soc d Ing e d Archit Ital—Sept—Oct., 1898. No. 24870 E.

Tropical Service.

Medical Outfit and Instructions for an Engineer in the Tropics. Albert L. Ashmead, in the *Medical Fortnightly*. Describes an outfit which the writer prepared for his brother. 900 w. Eng News—Dec. 1, 1898. No. 24329.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Agricultural Machinery.

United States Agricultural Machinery in Mexico. Reports a very promising outlook for trade in these implements, without competition from abroad. 900 w. U.S.Cons Repts, No. 310—Dec. 28, 1898. No. 24796 D.

American Industry.

The Causes of the Development of American Industry. (Die Ursachen der Entwickelung der Industrie in Amerika.) Karl Wittgenstein. An important address before the Society of Austrian Engineers showing the great development of American industries, and attributing it to the great liberty permitted, as well as to ease of communication. 10,000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 9, 1898. No. 24813 B.

American Trade.

American Expansion and Trade. Editorial on the important changes likely to arise from the Philippines falling into the hands of the United States. 1800 w. Engng—Nov. 25, 1898. No. 24430 A.

Opportunities for American Trade in Germany. Reports the classes of goods that could find a market, and gives information relating to the German readiness to imitate American goods. 1500 w. U. S. Cons Repts—Dec., 1898. No. 24518 D.

British Trade.

Competition of the United States with England. Clippings from British publications bearing on this subject, with comment on the excellence of American manufactures, and the weakness of Americans as traders. 1500 w. U. S. Cons Repts, No. 311—Dec. 29, 1898. No. 24798 D.

Competition with British Trade. Extracts from newspapers bearing on this subject, with portions of the report recently issued by the British Board of Trade. 11,000 w. U. S. Cons Repts—Dec., 1898. No. 24515 D.

Competition with British Trade in Brazil. From the report of H. M. Consul-general at Rio de Janeiro. Deals with causes of the British trade decreasing, and suggests methods of improvement in production and distribution. 1500 w. Prac Engr—Nov. 25, 1898. No. 24448 A.

China.

The Yangtse Basin and the British Sphere. Archibald Little. Descriptive sketch of this region and its resources. 5400 w. Jour Soc of Arts—Dec. 16, 1898. No. 24788 A.

Debts.

Collection of Debts in Belgium and in British Guiana. Memorandum of the law with respect to the collection of debts by aliens. 2500 w. U. S. Cons Repts, No. 308—Dec. 24, 1898. No. 24750 D.

Footwear.

Americans Losing Ground in Rubber Footwear. Notes that the exports in this line have greatly decreased, and shows that it is a field where Americans ought to lead. 1500 w. Ind Rub Wld—Dec. 1, 1898. No. 24342 D.

Foreign Trade.

Foreign Trade Policies. Reports in response to a request for information in regard to the policies adopted by the respective governments to extend foreign commerce. 23,000 w. U. S. Cons Repts, No. 307—Dec. 24, 1898. No. 24751 D.

Iron Exports.

Twenty-five Years of Iron and Steel Exports to Our Colonies. Deals with the exports of the United Kingdom to various parts of the Empire of hardware and cutlery, iron (wrought and unwrought), machinery and millwork. 2800 w. Col Guard—Nov. 25, 1898. No. 24428 A.

Japanese Trade.

Trade and Industry of Hiogo and Osaka. Notes items in the last Consular report for this district, which seems destined to become the most important in Japan from an industrial point of view, and the relations to the total trade of the country. 1800 w. Engng—Dec. 23, 1898. No. 25060 A.

Machinery.

Machinery for Cuba. Raphael S. Payne. Some points on the revival of industries and trade and the needs that will soon become pressing. 1700 w. Mfrs Rec—Dec. 16, 1898. No. 24585.

Machine Tools.

English and American Machine Tools. Editorial on the work done by American automatic machine tools, and the serious nature of American competition in this line. 1300 w. Engr, Lond—Dec. 2, 1898. No. 24617 A.

Manila.

Manila a Commercial Center of the East. On the value of Manila in a commercial way, with information of the effect already noticed in eastern trade in American products. 1000 w. Bradstreet's—Dec. 17, 1898. No. 24612.

Patent Laws.

Patent Laws and the Trading Community. Editorial discussion of a debate at the Article Club, London, especially considering the views of Mr. Fletcher Moulton. 4000 w. Engng—Dec. 16, 1898. No. 24747 A.

Pig-Iron.

The Late "Rig" in Cleveland Pig Iron. A discussion of the iron trade of this English district. 1300 w. Col Guard—Dec. 2, 1898. No. 24524 A.

Trade Following Pig Iron. William C. Dreher. Comments on the German fear of American competition, with report of the pig iron prices and related matters. 1500 w. Mfrs Rec—Dec. 16, 1898. No. 24586.

Port of New York.

The Commerce of the Port of New York. A statement of the fluctuations in the percentage of the foreign commerce of the United States passing through the port, and a review of measures proposed to increase its facilities. 1600 w. Eng Rec—Dec. 17, 1898. No. 24595.

Rhine Valley.

Commercial Facilities of the Rhine Valley. Information respecting the transportation between Mannheim, an important commercial center in southern Germany, and the sea coast. 900 w. U. S. Cons Repts, No. 312—Dec. 30, 1898. No. 24908 D.

Rubber Goods.

Exports of American Rubber Goods, Fiscal Year, 1897–98. Detailed statements from official sources, in advance of their publication by the U. S. Government, showing that such goods go to nearly every country in the world. 1800 w. Ind Rub Wld—Jan. 1, 1899. No. 24910 D.

Rubber Yield.

Decline in the Rubber Yield of Burma. Hawthorne Hill. A statement of the conditions existing in Burma, with the conclusion that other sources must be sought for an increase of the rubber supply. 1200 w. Ind Rub Wld—Dec. 1, 1898. No. 24343 D.

Russian Iron.

Production and Sale of Iron in Russia during 1897. The country has advanced to the fifth place in iron-producing. Gives information concerning the quality, production, prices, &c. 1600 w. U. S. Cons Repts—Dec., 1898. No. 24520 D.

Shipping Rates.

British and American Shipping Rates: Hindrances to American Exports. An editorial from the *Birmingham Post*, and a letter from G. H. Brydes, on the favorable rates from New York to Australia and New Zealand granted by the Tyler Line (British) to American merchandise, and the reasons. 3500 w. U. S. Cons Repts—Dec., 1898. No. 24516 D.

Siberia.

The Commercial Import of the Siberian Railway. (Die Wirthschaftlishe Bedeutung der Sibirischen Eisenbahn.) Dr. Mertens. A very full discussion as to the probable influence of the opening of the Siberian railway upon trade between Europe and the Far East. 6000 w. Glaser's Annalen—Dec. 15, 1898. No. 24821 D.

Trade Conditions.

Anglophobia. Edward Atkinson. Discusses briefly some of the causes that have kept English-speaking people at variance, and especially the false views of the nature of commerce. 2200 w. Harper's Wk—Dec. 24, 1898. No. 24683.

Trade Extension.

Does Trade Follow the Flag? Lord Farrar. An examination of statistics, presenting facts from the trade of the United Kingdom mainly, which show that extension of Empire is not necessarily followed by increase of trade. 10,000 w. Contemporary Rev—Dec., 1898. No. 24578 D.

U. S. Exports.

Suggestions for United States Export Trade. Discusses the elements that have retarded the development of this trade, and offer suggestions for facilitating its development. 900 w. U. S. Cons Repts—Dec., 1898. No. 24517 D.

CURRENCY AND FINANCE.

American Currency.

British Influence on American Currency Reform. W. R. Lawson. An interesting review of American currency questions as they appear to an Englishman. 6300 w. Bankers' Mag, Lond—Dec., 1898. No. 24514 D.

Interest.

Equitable Basis of Interest. Theodore B. Stark. An explanation and justification of the payment of interest on money. 3000 w. Gunton's Mag—Dec., 1898. No. 24422 C.

Paper Money.

Government Paper Money in the Light of Political Economy and of Experience. Fred O. McFarland. Read before the Bankers' Assn. of Illinois. Quotes views of leading political economists in regard to a government credit currency, reviews the experience of other nations, and the history of the issue of legal tenders in the U. S., with writer's opinions 4800 w. Bankers' Mag, N. Y.—Dec. 1898 No. 24577 D.

Puerto Rico.

The Money of Puerto Rico. William Dinwiddie. An explanation of the financial condition of the island and the difficult money problem to be solved. 3500 w. Harper's Wk—Dec. 31, 1898. No. 24797.

GOVERNMENTAL CONTROL.

Government.

The Relations of the United States to their New Dependencies. Capt. A. T. Mahan. An essay upon the best method of realizing the fruits of recent over-sea victories. Colonial systems are contrasted and the beneficence of Anglo-Saxon rule defined. Strong sea-power is urged and the most cogent arguments adduced in favor of the retention of these colonial possessions. Lessons are drawn from the success or failure of other colonial systems and the internal development of each colony by wise administration and attention to the needs of the inhabitants is insisted upon. 2300 w. Engineering Magazine—Jan., 1899. No. 24890 B.

LABOR.

Laborers.

The Scarcity of Workmen. (Ueber den Arbeitermangel.) A discussion of the causes of the scarcity of workmen in Germany, this being mainly attributed to higher wages attracting skilled workmen to other countries. 2000 w. Stahl und Eisen—Dec. 1, 1898. No. 24931 D.

New Association.

The American Railway Engineering and Maintenance of Way Association. L. C. Fritch. On the need of organizing the association; also editorial. 2500 w. Ry & Engng Rev—Dec. 17, 1898. No. 24660.

Relief Associations.

Mutual Relief and Benefit Associations in the Printing Trade. William S. Waudby. Presents an account of the mutual relief and benefit associations in the printing and allied trades. 10,000 w. Bul of the U. S. Dept of Labor—Nov., 1898. No. 24349 D.

Socialism.

A French View of Socialism and English Trade Unions. Reviews the criticism of the influence of socialism on English working people as given in a recent book by M. Demolins. 2000 w. Jour Gas Lgt—Nov. 22, 1898. No. 24454 A.

Strikes.

Board of Trade Report on Strikes. Editorial discussion of this report on strikes and lockouts in Great Britain, for 1897. 2800 w. Builder—Nov. 26, 1898. No. 24450 A.

MISCELLANY.

Canal Traffic.

The Traffic of Notable Canals. Abstract of figures and general information from a condensed summary issued by the Bureau of Statistics of the United States. 800 w. Ry & Engng Rev—Dec. 10, 1898. No. 24567.

Combines.

Electric and Railway Combines in New York. On the tendency to combine electric street railway corporations, with those supplying electricity for light and power. Especially referring to the New York company. 1000 w. Bradstreet's—Dec. 17, 1898. No. 24611.

Cuba.

Cuba from the Standpoint of a Cuban Engineer—Prospects for Business and Work. J. de T. Tejada. A statement of past and existing conditions. 2800 w. Am Mach—Dec. 22, 1898. No. 24699.

Education.

Commercial Education. Albert Rollit. Shows England's need of commercial education, reviews what has been done by other countries, and discusses the requirements. Discussion follows. 14000 w. Jour Soc of Arts—Dec. 16, 1898. No. 24789 A.

Commercial Education in the United States. Editorial on the need of special business training for those who are to follow commercial life. 1000 w. Eng News—Dec. 8, 1898. No. 24499.

English Views of Technical Education. W. S. Aldrich. Letter to the editor. 900 w. Eng Rec—Dec. 3, 1898. No. 24359.

The Training of the Engineer. (Zur Frage der Ingenieurausbildung.) Dr. Walther Dyck. Treating especially of the value of training in physics and the natural sciences 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 12, 1898. No. 24801 D.

Expansion.

The Engineer and the Policy of National Expansion. Charles B. Going. An essay upon the place of the engineer in the advance of nations. It is argued that the engineer is the real pioneer in modern national expansion, that he is the moving spirit in all material advance and that to him, solely, is due the steady and rapid rise in the standard of living, the gain in security and comfort to the individual and the vast increase in production. In all directions of growth the engineer has the closest and largest interest and to him comes the first and greatest reward. 2300 w. Engineering Magazine—Jan., 1899. No. 24891 B.

Lumbering.

Machinery and Power Applications in the Lumber Industry. William Adams. This well illustrated article gives a graphic description of the methods and machinery used in the redwood forest belt of California. The trees handled are very large and the wood somewhat brittle, so great care is requisite in felling and subsequent operations. The method of loading the logs by a cableway is also described. 3500 w. Engineering Magazine—Jan., 1899. No. 24896 B.

Paris Exposition.

The Paris Exposition of 1900. Francis E. Drake. Illustrates the general plan of arrangement and location of the buildings, and describes the features of machinery and electricity. 5500 w. W Elect'n—Dec. 10, 1898. No. 24553.

Patent Law.

The German Patent Law, and the Proper Remedy of the Engineer. (Das Deutsche Patentgesetz und die Wissenschaftliche Hülfsmittel des Ingenieurs.) Prof. A. Riedler. A discussion of the scope of the German patent law, with an elaborate examination of the recent decision in connection with the Schlick system of balancing engines. 9000 w. Zeitschr d Ver Deutscher Ing—Nov. 26, 1898. No. 24806 D.

Russia.

What We Saw in Russia. A. S. A report of the industrial conditions, with review of the history of the people. 3800 w. Loc Engng—Dec., 1898. No. 24398 C.

Tin Plate.

American Tin Plate Co. An account of the organization, personnel and charter. 4400 w. Ir Trd Rev—Dec. 22, 1898. No. 24689.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Batteries.

Batteries for Exchange and Toll-Line Use from the Point of Economy and Excellence of Service. S. A. Dinsmore. Discusses dry and wet batteries and their use. 2000 w. Elec Engng—Dec., 1898. No. 25716.

Cables.

Ocean Cables. A short summary of a communication from Sir Sanford Fleming, of Ottawa, on the subject of a state owned system of electric cables for the British empire, to circle the earth. 600 w. Bos Jour of Com—Dec. 24, 1898. No. 24768.

Exchanges.

Centralized Sources of Energy in Telephone Exchanges. Kempster B. Miller. Shows the great development that has taken place in this line of work. The scope of the article includes the centralization of both calling and talking batteries. Ill. 2500 w. Elec Wld—Dec. 24, 1898. Serial. 1st part. No. 24693.

The New Exchange of the House Telephone Company, Trenton, N. J. Illustrated description. 1200 w. Elec Wld—Dec. 24, 1898. No. 24692.

Intercommunication.

Electric Intercommunication in Railway Trains. W. E. Langdon. Read at meeting of the Inst. of Elec. Engs., London. Considers (1) the electrical system ; (2) mode of connecting vehicles ; (3) the means for claiming the attention of the officials in charge of the train. Ill. 3700 w. Elec Eng, Lond—Dec. 16, 1898. Serial. 1st part. No. 24795 A.

Light Telegraphy.

Further Researches in Telegraphing with Light and Electricity. (Weitere Versuche über die Licht-elektrische Telegraphie.) K. Zickler. An account of the later experiments with ultra-violet light, and electrical discharges. Communication has been successfully held over a space of 1.3 kilometre. 1200 w. Elektrotech Zeitschr—Dec. 8, 1898. No. 24845 B.

Printing Telegraph.

The Higgins Type-Printing Telegraph Apparatus. Illustrated detailed description of improved apparatus possessing points of novelty.

1300 w. Elect'n, Lond—Dec. 9, 1898. No. 24629 A.

Selector System.

The Drake Selector System. Thomas C. Drake. Describes this system as worked out by the writer. Ill. 3600 w. Elec Engng—Dec., 1898. No. 24715.

Space Telegraphy.

Etheric Telegraphy. W. H. Preece. An interesting review of personal experience with this form of communication, and remarks on the Marconi system. 3000 w. Engr, London—Nov. 25, 1898. No. 24434 A.

Improvements in Magnetic Space Telegraphy. Oliver Lodge. Read before the Inst. of Elec. Engs., London. Reviews briefly the three chief methods, and explains the writer's system of magnetic induction telegraphy, and the sensitive receiving instrument which may be employed with it. 4200 w. Ind & Ir—Dec. 16, 1898. Serial. 1st part. No. 24737 A.

Wireless Telegraphy. Translation of an article by M. Ducretet, explaining his theory. 1000 w. U. S. Cons Repts, No. 306—Dec. 23, 1898. No. 24706 D.

Telegraph Cars.

The Postal Telegraph Company's Caravan. Description and illustration of the cars and equipment to be used while working in desolate regions. 1200 w. Elec Eng, N. Y.—Dec. 1, 1898. No. 24308.

DISTRIBUTION.

Alternating Currents.

Notes on the Distribution of Alternating Currents. Sidney E. T. Ewing. Notes indicating the apparatus and methods in most general use, with comments. 2800 w. Elec Eng, Lond—Dec. 16, 1898. Serial. 1st part. No. 24794 A.

Rotary Converters.

Rotary Converters. (Les Machines à Courant Alternatif "Commutatrices.") Eug. Miot. Description, with illustration, of a sub-station in Paris containing rotaries of the "Alioth" type, with details of the machines. 1200 w. L'Electricien—Dec. 3, 1898. No. 24869 B.

The Converter. C. P. Steinmetz. An article discussing the peculiarities of this machine in the way of armature heating, field reaction, &c. 4500 w. Elec Wld—Dec. 17, 1898. Serial. 1st part. No. 24584.

The Theory of the Rotary Transformer. Gisbert Kapp, in the *Elektrotechnische Zeitschrift*. The first part of a serial discussing the general principles upon which the transformation of currents is based. 1100 w. Elect'n, Lond—Nov. 18, 1898. Serial. 1st part. No. 24319 A.

Subways.

Electrical Subways, Providence, R. I. Illustrated description of the construction of subways in which special attention is paid to manholes with shelves for the cables. 900 w. Eng Rec—Dec. 3, 1898. No. 24365.

Three-Wire.

Regulation of Pressure in Three Wire Systems for Continuous Currents. (Spannungsregulirung in Dreileiternetzen für Gleichstrom.) C. del Proposto. Comparing the relative economy of different methods of regulation, with diagrams showing the corresponding arrangement of connections. 2000 w. Elektrotech Zeitschr—Dec. 8, 1898. No. 24844 B.

Wiring.

Concentric Wiring. Editorial examination of arguments for and against concentric wiring. 1600 w. Elect'n, Lond—Dec. 16, 1898. No. 24793 A.

ELECTRO-CHEMISTRY.

Accumulators.

The Present Status of Accumulator Manufacture. (Der Gegenwärtige Stand der Accumulatorentechnik.) A paper by Dr. Müllendorf before the German Society of Mechanical Engineers discussing the existing condition of electrical accumulators from a practical standpoint, especially as regards resistance to the wear and tear of daily use. 4000 w. Glaser's Annalen—Dec. 15, 1898. No. 24820 D.

The Theory of the Accumulator. Summary of an article in the *Elektrotechnische Rundschau*, in which Prof. Hoppe, of Hamburg, applies the electro chemical theory to accumulators. 2200 w. Elec Rev, Lond—Nov. 18, 1898. No. 24317 A.

Batteries.

The Use of Storage Batteries at Sea. Presents some of the dangers to an electric plant at sea, and the value of the storage battery in case of the possible accident. 1400 w. Elec Rev, N. Y.—Dec. 14, 1898. No. 24565.

Some Useful Forms of Galvanic Elements. (Ueber Einige Formen der Gebräuchlichsten Galvanischen Elemente.) E. Petersen. Data of tests upon various forms of primary batteries, investigating the chemical reactions. 2000 w. Zeitschr f Electrochemie—Dec. 1, 1898. No. 24848 G.

Carborundum.

The Manufacture of Carborundum at Niagara Falls, Ont. Brief description of the process of manufacture. 1000 w. Can Engr—Dec., 1898. No. 24552.

Chlorate Works.

The St. Michel Electrolytic Chlorate Works. John B. C. Kershaw. Brief illustrated description of these interesting works in France. 1300 w. Elec Rev, Lond—Nov. 25, 1898. No. 24444 A.

Electrolytic Bleach.

Electrolytic Bleach. (La Sbianca Elettrica.) A short general summary of electrolytic methods for making bleaching agents with data of power absorbed and costs. 900 w. L'Elettricitá—Oct. 30, 1898. No. 24859.

Electrolytic Cells.

Efficiency of the Electrolytic Cell. C. F. Burgess. Discusses methods of studying the efficiency of an electrolytic process, and the utilization of the energy of the electrolytic cell. 3000 w. Elec Wld—Dec. 24, 1898. No. 24694.

Polarization and Internal Resistance of Electrolytic Cells. K. E. Guthe. Describes, with a diagram, laboratory methods of studying behavior of electrolytic cells. 1200 w. Phys Rev —Nov., 1898. No. 24490 D.

Electro-Metallurgy.

A Dissertation on Electro-Metallurgy. J. Wright. Discusses briefly the mechanical separation of iron ores by the aid of magnetic devices, the separation of the precious metals by means of the electric current, and electric welding. Ill. 4500 w. Ind & East Engr—Nov., 1898. No. 24651 D.

Magnetism.

Notes on the Chemical Action of Magnetism. (Beitrag zur Chemischen Wirkung des Magnetismus.) E. Jahr. An account of numerous experiments upon the influence of magnetism upon chemical action, with plates of photographic reproductions of phenomena. 2000 w. 2 plates. Elektrochem Zeitschr—Dec., 1898. No. 24847 G.

Review.

The Progress of Electrochemistry and Electrometallurgy during the Past 25 years. (Die Fortschritte der Elektrochemie und Elektrometallurgie Während der Letzten 25 Jahre.) A general review of the development of the industrial applications of electricity to chemistry and metallurgy in the last quarter of the century. 3000 w. Elektrochem Zeitschr—Nov., 1898. No. 24846 G.

Silicon.

The Effect of Silicon on the Magnetic Permeability of Cast Iron. F. C. Caldwell. Results of tests made upon castings poured from a small cupola, the variation in silicon being obtained by the addition of silvery iron. 500 w. Elec Wld—Dec. 10, 1898. No. 24481.

Sugar.

The Purification and Bleaching of Sugar Solutions. (Reinigung und Entfarbung Zuckerhaltiger Flüssigkeiten.) Franz Peters. A comparison of methods of purification of sugar by ozone, by electricity, and by both combined; results of experiments are given. 2000 w. Zeitschr f Elektrochemie—Dec. 1, 1898. No. 24926 G.

Timber.

Electricity and the Seasoning of Timber. A brief description of an important and novel process for the rapid seasoning of timber by the aid of electricity. 700 w. Arch, Lond—Dec. 9, 1898. No. 24627 A.

Voltaic Action.

On the Relation between the Heat Evolved and the E. M. F. Generated by Voltaic Action. Desmond G. FitzGerald. Considers the question in its bearings on the theory of lead reversible batteries. 3400 w. Elec Eng, Lond—Nov. 25, 1898. No. 24440 A.

White Lead.

Some Notes on the Manufacture of White Lead. Sherard Cowper-Coles. Part first describes various stack and chamber methods and electrolytic methods. Ill. 4800 w. Ind & Ir —Dec. 16, 1898. Serial. 1st part. No. 24738 A.

ELECTRO-PHYSICS.

Cathode Rays.

The Magnetic Deflection of Reflected Cathode Rays. Ernest Merritt. Interesting experimental research described, with conclusion that Crookes' hypothesis is the most nearly correct. 5500 w. Phys Rev—Nov., 1898. No. 24493 D.

Current Generating.

Thermo-Electric and Galvanic Actions Compared. Charles J. Reed. Considers thermo-electric and galvanic actions that have been the cause of confusion, and giving illustrations for aid in determining whether a reaction is galvanic or thermo-electric. Discussion follows. Ill. 7500 w. Jour Fr Inst—Dec., 1898. No. 24466 D.

Electrical Waves.

On the Influence of the Thickness of Air-Space on Total Reflection of Electric Radiation. J. Chunder Bose. Read before the Royal Soc. Investigations of this subject, studying the influence of the angle of incidence and of the wave-length in modifying the thickness of the effective air-space. 9500 w. Elect'n, Lond—Nov. 25. 1898. No. 24445 A.

The Measurement of Short Electrical Waves and their Transmission Through Water Cells. A. D Cole. Paper read before the Am. Assoc. for the Adv. of Sci. Brief account of experimental work on the index of refraction and absorption of water for waves of 5, 8 and 16 centimetres length. 3000 w. Phys Rev—Nov., 1898. No. 24494 D.

The Refraction of Electric Waves. Abstracts of two papers communicated to the Royal Society by Jagadis Chunder Bose, "On the Determination of the Indices of Refraction of Various Substances for the Electric Ray" and "On the Influence of the Thickness of Air Space on Total Reflection of Electric Radiation." Published in *Nature*. Ill. 1700 w. Sci Am Sup—Dec. 3, 1898. No. 24338.

Magnetic Field.

The Rotating Magnetic Field. Henry H. Norris. The discussion is confined to the primary circuits and the magnetomotive forces and consequent magnetic induction produced therein. 2000 w. Sib Jour of Engng—Dec., 1898. No. 24663 C.

Magnetism.

Modern Investigations in Terrestrial Magnetism and Currents. (Ueber Neuere Forschungen auf dem Gebiete des Erdmagnetismus und der Erdstrome.) Dr. Weinstein. A discussion of recent observations on terrestrial magnetism in Germany, with diagrams of the horizonal elements between 1884, 1887. 2000 w. Elektrotech Zeitschr—Nov. 24, 1898. No. 24839 B.

The Modern Theory of Magnetism. (Die Moderne Theorie des Magnetismus.) Dr. H. Du Bois. A discussion by the aid of quaternions, of Hopkinson's theory, read before the Mathematical Assn. at Düsseldorf. 3000 w. Elektrotech Zeitschr—Nov. 24, 1898. No. 24838 B.

Observatory.

The Toronto Magnetic Observatory. R. F. Stupart. An account of the establishment of the magnetic observatory in Canada, the buildings used, especially the one recently built. This building was made necessary as the observations at the Toronto observatory were seriously impaired by the trolley system. The greatest care was taken in its construction. 3000 w. Ter Mag—Dec., 1898. No. 24909 E.

GENERATING STATIONS.

Armature Currents.

Distribution of Currents and Energy in Short-Circuited Armatures. (Stromvertheilung und Energieaufnahme von Kurzschlussankern.) G. Roessler. A very exhaustive discussion of the action of the electrical currents in the Dobrowolski armature, using both graphical and analytical methods. Two articles. 10,000 w. Elektrotech Zeitschr—Nov. 10, 17, 1898. No. 24834 each B.

Brooklyn.

The New Work of the Brooklyn Edison Company. Illustrates and describes the main generating station and its equipment, and the installation of a 6000-volt high-tension system. 3000 w. Elec Wld—Dec. 3, 1898. No. 24383.

Design.

The Direction of Progress in the Design of Electric Lighting Plants. Considers the separate items of the plant and the forms modern experience is giving them in England. 4500 w. Engr, Lond—Nov. 25, 1898. No. 24437 A.

Dynamo.

The Largest Dynamo in the World. S. H. Short. Illustrations and description of the 3000 kilowatt machine for Boston Elevated Ry. Co., its construction, and the weights of its various parts. 1000 w. Ry Wld—Dec. 8, 1898. No. 24901 A.

Running Shunt Dynamos in Parallel. Arnold Philip. Considerations and experiments of interest in connection with the recent break-down at Brighton, Eng. 1600 w. Elec'n, Lond—Nov. 25, 1898. No. 24446 A.

Electrical Machinery.

Multiphase Electrical Machinery. Andrew Stewart. Abstract of a paper awarded the Gold Medal of the Glasgow and West of Scotland Technical College Scientific Society. Information regarding the leading features of the multiphase system, with special reference to the generators and motors, their efficiency and regulation. 1800 w. Elec, Lond—Nov. 25, 1898. Serial. 1st part. No. 24558 A.

Field.

The Magnetic Field of a Bipolar Generator. (Das Magnetfeld einer Zweipoligen Dynamo-Maschine.) Dr. H. Hess. The distribution of the lines of force is very well shown by reproductions of iron-filing patterns, and the difference in action between a dynamo and a motor explained. 1500 w. Elektrotech Zeitschr—Nov. 17, 1898. No. 24835 B.

Isolated Plant.

A Large Isolated Plant. Illustrates and describes the plant at the Royal Agricultural Hall, Islington. 1500 w. Elec Rev, Lond—Dec. 9, 1898. No. 24634 A.

The Electric Lighting Equipment at Knowsley Hall. Illustrates and describes the buildings, generating plant, fittings and methods of lighting. 4500 w. Elec Eng, Lond—Dec. 9, 1898. No. 24630 A.

The Lighting and Power Plant of the Chicago Public Library Building. Illustrated description of an interesting plant. 2200 w. Elec Wld—Dec. 17, 1898. No. 24583.

Italy.

Electric Light and Power Plants in Naples and Trieste. (Impianti Elettrici per Luce e Forza in Napoli e in Trieste.) Carlo Gabussi. Brief description of two important installations, one of the direct-current accumulator sub-station type and the other of the single-phase alternating current variety. 1500 w. Giorn dei Lav Pubb e delle Str Ferr—Nov. 23, 1898. No. 24852 B.

Motor Works.

The Langdon-Davies Motor Works. An illustrated description of this motor, and the works where it is constructed. 1200 w. Elect'n, Lond—Dec. 2, 1898. No. 24562 A.

Paris.

Paris Central Electric Stations. Illustrates and describes some of the most important stations, noting their interesting features. 1600 w. Engr, Lond—Nov. 25, 1898. No. 24436 A.

The Place Clichy Central Station in Paris. L. Bayly. Illustrates and describes in detail the equipment. The five-wire system of distribution is used. 1500 w. Elec Rev, N. Y.—Nov. 30, 1898. No. 24309.

Power Plant.

The Installation of a Power Plant. U. Grant Kirn. The writer aims to give such information as would enable an engineer capable of taking charge of a plant, to also erect it. Ill. 7000 w. Engr, U. S.—Dec. 1, 1898. No. 24471.

The Plant of the Colorado Electric Power Company. Ralph D. Mershon. An illustrated detailed description of a plant designed with the object of supplying power to the gold mines. 2500 w. Am Elect'n—Dec., 1898. No. 24473.

Profits.

Profits of Alternating-Current Central Stations. T. M. Meston. Urges the establishment of day circuits for power users in connection with intelligent canvassing. 1000 w. Am Gas Lgt Jour—Dec. 12, 1898. No. 24549.

Sparking.

The Causes of Sparking at the Commutators and Brushes of Continuous-Current Dynamos. (Ueber die Ursachen der Funkenbildung an Kollektor und Bürsten bei Gleichstrom-dynamos.) Emil Dick. A discussion in which formulas are derived for fields of various strengths and brushes of different materials, enabling the best dimensions to be computed for any given case. 3500 w. Elektrotech Zeitschr—Dec. 1, 1898. No. 24841 B.

Switzerland.

The Electric Plant at Arosa. (Das Elektricitätswerk Arosa.) An excellently illustrated illustrated account of the hydraulic electric plant at this popular Swiss resort. Over 300 h. p. are developed from a small mountain stream. Two articles. 2500 w. Schweizerische Bauzeitung—Dec. 3, 10, 1898. No. 24831 each B.

Transformers.

Transformers in Practice. Traces the improvements in design of transformers, giving illustrated descriptions of three types in favor in England, with general remarks of interest. 5000 w. Engr, Lond—Nov. 25, 1898. No. 24435 A.

LIGHTING.

Arc.

A Photographic Study of the Electric Arc. N. H. Brown. Experimental research upon the seat of luminosity and method of formation of the arc, illustrated with three photogravure plates. 5000 w. Phys Rev—Nov., 1898. No. 24492 D.

Lighting in Gt. Britain.

The Commercial Aspects of Electric Lighting in Great Britain. Robert Hammond. A study of the cost of production of electrical energy in the United Kingdom. The curious Parliamentary regulations governing the establishment of electric lighting plants are described at length, and a comparison made between eleven stations showing low producing costs. The paper is highly instructive and of great interest. 4000 w. Engineering Magazine—Jan., 1899. No. 24899 B.

Lighting Plant.

A Gas Engine Electric Lighting Plant for the French Chamber of Deputies. Description, with illustration of a very large gas-engine plant comprising no fewer than 4610 lamps, aside from the Chamber itself. 900 w. Elec Eng, N. Y.—Dec. 8, 1898. No. 24459.

Street Lighting.

Festoons of Incandescents on Chicago Business Streets. Illustrated account of the street illumination during the Peace Jubilee celebration, and its great success. 800 w. Elec Eng, N. Y.—Dec. 22, 1898. No. 24669.

Vienna.

The Electric Lighting Plant of the Vienna City Railway. (Elektrische Beleuchtungsanlagen der Wiener Stadtbahn.) W. Koula. With a map of the distribution, and plans and views of buildings, machinery, and switchboard. 3000 w. Elektrotech Zeitschr—Dec. 1, 1898. No. 24840 B.

MEASUREMENT.

Alternating Currents.

Graphic Method for Studying Alternating Currents. (Résumé de la Méthode Graphique pour l'Etude des Courants Alternatifs.) S. Hanappe. A very elaborate mathematical treatise. It deals with the application of graphical methods to the study of machines. Illustrated with many diagrams. Serial. 1st part. 24,000 w. Rev Univ des Mines—Nov., 1898. No. 24878 G.

Capacity.

The Computation of the Electrostatic Capacity of Overhead Conductors. (Ueber die Berechnung der Elektrostatischen Kapacität Oberirdischer Leitungen.) F. Breisig. An approximate solution, taking into account the influence of the surface of the earth, the proximity of wires, and the general working conditions. 5000 w. Elektrotech Zeitschr—Nov. 17, 1898. No. 24836 B.

Diagrams.

Graphical Representations of the Gross Output of Electric Railways. (Graphische Ermittelung der Bruttoabgaben Elektrischer Bahnen.) Wilhelm Mattersdorff. Describing a method of plotting the total work of an electric railway by use of curves; illustrated by examples from Berlin tramways. 1800 w. Elektrotech Zeitschr—Dec. 8, 1898. No. 24843 B.

High Pressures.

On an Apparatus for Measuring Very High Pressures. A. de Forest Palmer, Jr. Describes the method adopted, which gave very satisfactory results. 900 w. Am Jour of Sci—Dec., 1898. No. 24347 D.

Mathematical Theory.

Report on the State of the Mathematical Theory of Electricity and Magnetism. Arthur Gordon Webster. Reviews the principal points of the development of the theory of electricity and traces its progress, 3300 w. Science—Dec. 9, 1898. No. 24477.

Meters.

Meters and Systems of Charging for Electric Energy. William Arnot. Abstract of a paper read before the Inst. of Engs. and Shipbuilders in Scotland. Discusses the costs and methods of charging. 4800 w. Elec Eng, Lond—Dec. 2, 1898. No. 24556 A.

Phasemeter.

Dr. Th. Burger's Direct Reading Phasemeter. (Phasemètre à Lecture Directe du Dr. Th. Burger.) M. Aliamet and E. J. Brunswick. A dynamometer type phasemeter of very simple construction described and illustrated. 1000 w. L'Electricien—Nov. 26, 1898. No. 24868 B.

Photometer.

A Device for Recording Photometer Settings. Charles P. Matthews. Illustrated description of a simple and ingenious device greatly improving both the speed and accuracy of photometer work. 1200 w. Phys Rev—Nov., 1898. No. 24495 D.

Resistances.

Notes on the Practical Measurement of Low Electrical Resistances. J. Warren. Investigations as to what constitutes the difference of potential. 1000 w. Elec, Lond—Nov. 25, 1898. Serial. 1st part. No. 24559 A.

Wattmeters.

A Hot-Wire Combined Ampere-Volt Wattmeter. Michael B. Field. Describes a hot-wire instrument devised by the writer for use in testing rooms, laboratories, &c., as a handy and accurate appliance for determining the conditions obtaining in any circuit, viz., the current strength, voltage, power, and power factor. 2200 w. Elec Rev, Lond—Nov. 25, 1898. Serial. 1st part. No. 24441 A.

POWER APPLICATIONS.

Cranes.

The Electric Cranes of the Southampton Harbor Board. Illustrated detailed description of the new cranes. The installation consists now of six electrically-driven travelling jib cranes. 1400 w. Engr, Lond—Dec. 2, 1898. No. 24532 A.

The New Electric Cranes at Southampton Harbor. Illustrated description of these cranes and report of their satisfactory work. 1300 w. Elect'n, Lond—Nov. 18, 1898. No. 24321 A.

Elevators.

Fatal Elevator Accident in New York. Describes an unusual accident to an electric elevator due to the falling of counterbalance weights. 1200 w. Eng Rec—Dec. 10, 1898. No. 24536.

Equipment.

Electrical Equipment of the Columbia Gas Coal Company, at West Newton, Pennsylvania. George R. Wood. Illustrated description of pumping and coal-cutting machinery. 1700 w. Mines & Min—Dec., 1898. No. 24368 C.

Mine Plant.

The Electric Plant of the "Glückauf" Mine at Sondershausen. (Der Elektrische Centralbetrieb der Gewerkschaft "Glückauf" zu Sondershausen.) A very complete account of the electric power station, distribution system, and various applications of electric power at the great potash mine at Sondershausen, Saxony. 8000 w. 4 plates. Glückauf—Dec. 3, 1898. No. 24826 B.

Motors.

Induction Motors with Variable Speeds. (Ueber Induktions Motoren mit Veränderlicher Umlaufzahl.) F. Niethammer. A discussion of methods of winding by means of which rotary field motors may be arranged to run at different speeds merely by moving a switch. 2500 w. Elektrotech Zeitschr—Nov. 10, 1898. No. 24833 B.

The Electric Motor in Shop and Mine. Clarence M. Barber. Notes points interesting to the engineer who is not an electrician, but who is interested in electrical power transmission, and on the present status of the machine, 5000 w. Jour Assn of Engng Soc's—Nov., 1898. No. 24711 C.

Navigation.

The Electrical Navigation of Rivers. (La Navigazione Elettrica Fluviale.) T. Tommasina. An argument in favor of the navigation of rivers, in Italy, by means of accumulator boats. 900 w. L'Elettricità—Oct. 30, 1898. No. 24858.

Polyphase Motors.

Polyphase Motors with Single Phase Armature Winding. (Ueber Drehstrommotoren mit Einphasiger Ankerwickelung.) Hermann Cahen. A discussion of a paper by H. Görges, describing a motor in which a reduced number of coils are used in the armature. 2500 w. Elektrotech Zeitschr—Dec. 8, 1898. No. 24842 B.

Workshops.

Electric Power in Workshops. Alex. Siemens. Traces the progress made in generating, transmitting and utilizing the energy, and shows its suitability for driving machinery. 1500 w. Engng Mech—Nov., 1898. No. 24395 C.

TRANSMISSION.

Aluminum.

The Conductivity of Aluminum. Edwin F. Northrup. Gives recent tests made on rods manufactured by the Pittsburg Reduction Company, some of the specimens being pure aluminum and others alloyed with copper. 600 w. Elec Wld—Dec. 3, 1898 No. 24384.

Electric Transmission.

Electric Transmission at the New Works of the Linotype Company. Illustrates and describes the works at Broadheath, Eng., also the electric plant, system of transmission, &c. 6500 w. Engr, Lond—Nov. 25, 1898. No. 24438 A.

Hamilton, Can.

The Hamilton, Can., Cataract Power Co.'s Plant at De Cew Falls. George W. Bowie. Illustrated detailed description of a long-distance transmission plant with many novel features. 3000 w. Elec Eng, N. Y.—Dec. 8, 1898. No. 24458.

Insulating Materials.

Dielectric Strength of Insulating Materials. Thomas Gray. Paper read before the Am. Assn. for the Advancement of Sci., containing results of measurements of various substances. 3500 w. Phys Rev—Nov., 1898. No. 24491 D.

Long Distance.

Long Distance Transmission of Electric Power. George Forbes. A paper advocating long distance transmission, and considering the methods in use, and various industries to which it is applicable. Discussion. 7500 w. Jour Soc of Arts—Nov. 25, 1898. No. 24439 A.

Long Distance Transmission of Power. C. Rice Dooley. From *The Purdue Exponent.* Calling attention to growth of water-power generating plants, citing examples. 1400 w. Elec, N. Y.—Nov. 30, 1898. No. 24307.

Mains.

High-Tension Trunk Mains. Gives the experience in trying to furnish current for the Deptford station, London, and the first use of the Ferranti Trunk Main, describing it. and giving recent experience with high-tension mains, and with insulating materials. 6300 w. Engr, Lond—Dec. 2, 1898. No. 24527 A.

Paderno.

The Water-Power Installation at Paderno. G. Semenza. Lecture given before the Milan section of the Associazione Elettrotecnica Italiana. An illustrated detailed description of an interesting power transmission scheme. 1600 w. Elect'n, Lond—Dec. 16, 1898. Serial. 1st part. No. 24792 A.

Power Transmission.

Polyphase Transmission of Power. F. Wallis. Discusses the various questions relating to long-distance transmission, and how the polyphase system compares with the direct-current and with the single-phase alternating. 4400 w. Elect'n, Lond—Dec. 9, 1898. No. 24628 A.

Transmission Plant.

The San Gabriel–Los Angeles Transmission Plant. George P. Low. Illustrated detailed description of this interesting installation and its many novel features. 17,500 w. Jour of Elec—Nov., 1898. No. 24773.

MISCELLANY.

Influence.

The Social Influence of Electric Power. Editorial discussion of the influences due to electric traction and to electric motors. 1800 w. Elect'n, Lond—Nov. 18, 1898. No. 24320 A.

Invention.

The Status of Electrical Invention. William A. Rosenbaum. It is proposed to take up the main branches, and to call attention to the inventions in each. The present article deals with the telegraph and telephone. 3000 w. Jour Fr Ins—Dec., 1898. No. 24467 D.

MARINE ENGINEERING.

Compass.

The Mariner's Compass. Ernest K. Roden. Reviews what is known of the invention; describes Sir William Thompson's compass, the best one in use at the present time, discusses variations, &c. Ill. 3000 w. Home Study—Jan., 1899. No. 24686.

Construction Rules.

Wimshurst's Rules for the Construction of Steam Vessels. Gives rules for the construction of steel vessels, with editorial. 5000 w. Engng—Dec. 16, 1898. No. 24748 A.

Fire Boat.

New and Powerful Fire Boat for the City of Chicago. Illustrates and describes the chief features of the design and construction of a vessel embodying the most modern ideas for this class. 1800 w. Marine Engng—Dec., 1898. No. 24544 C.

Launches.

Our Builders Where Naphtha Launches Grow. Describes a visit to the works of the Gas Engine and Power Co., and Charles L. Seabury & Co., at Morris Heights, N. J. Ill. 1800 w. Rudder—Dec., 1898. No. 24391 C.

Load-Line.

The Report of the Load-Line Committee. Editorial stating the circumstances which led to the appointment of the committee, and commenting on the report just presented to the Board of Trade. 2200 w. Engr, Lond—Dec. 16, 1898. No. 24742 A.

Machinery.

The Machinery of Vessels on the Great Lakes and a Synopsis of Rules Compiled by the Great Lakes Register. John N. Coffin. An outline of some of the results which have been developed in compiling the Great Lakes Register. 4800 w. Jour Assn of Engng Soc's—Nov., 1898. No. 24709 C.

Merchant Marine.

School for Merchant Marine in Russia. Translation of the regulations for the management of an institution recently organized, which has for its object the training of young men in the theory and practice of navigation. 3000 w. U. S. Cons Repts, No. 309—Dec. 27, 1898. No. 24749 D.

Sea Power.

America's Inadequate Sea Power. Editorial on the importance of the export trade, and the necessity for increasing the ocean shipping. 1000 w. Ir Age—Dec. 1, 1898. No. 24335.

Ship Construction.

The Morbid Anatomy of Iron and Steel Ships. S. J. P. Thearle. Lecture delivered to the Glasgow Univ. Engng Soc. An examination of the diseases to which these ships are liable, and the advances being made in overcoming them. 5000 w. Engr, Lond—Dec. 9, 1898. Serial. 1st part. No. 24649 A.

Shipping.

Positive Shipping Policy. The project for the creation of an American seagoing merchant fleet recommended by the Commissioner of Navigation. 2000 w. Marine Rev—Dec. 8, 1898. No. 24508.

Ships' Magnetism.

The Magnetism of Ships. (Il Magnetismo Navale.) Prof. E. Gelcich. An elaborate study of the variations of compasses on ships and the theory of compensation. It is prefaced by an interesting and valuable historical study of the subject. Serial. 1st part. 11,000 w. Rivista Marittima—Nov., 1898. No. 24876 H.

Steamer.

The "Duke of Cornwall." Illustrates and describes this new cross Channel mail steamer, built for the Fleetwood and Belfast route. 2000 w. Engng—Dec. 16, 1898. No. 24745 A.

Steam Navigation.

Reminiscences of Early Marine Steam Engine Construction and Steam Navigation in the United States of America from 1807 to 1850. Charles H. Haswell. Read at meeting of Inst. of Naval Arch'ts, March 31, 1898. 3000 w. Jour Am Soc of Nav Engs—Nov., 1898. No 24350 H.

Steamship Trial.

Trial of the Steel Cargo Steamship Winifred. A. D. Haughton. A full description of the vessel and report of the trials. The ship goes immediately on the New York and Porto Rico steamship route. 3300 w. Jour Am Soc of Nav Engs—Nov., 1898. No. 24353 H.

Steam Yacht.

Description of the Steam Yacht Ellide and

Her Speed Trials. Illustrates and describes the boat and machinery, giving report of trials and a discussion of results. 2500 w. Marine Engng—Dec., 1898. No. 24543 C.

Steam Yacht Hildegarde. Illustrated detailed description with history of the vessel. 2500 w. Rudder—Dec., 1898. No. 24390 C.

Steel Ships.

On Some Features of the Repairs and Construction of Iron and Steel Ships. M. W. Aisbitt. Read at meeting of the North-East Coast Inst. of Engs. and Shipbuilders, at Newcastle-on-Tyne. Notes from one long engaged in the work. Discusses stanchions, web frames, double-bottoms, &c. Ill. 2500 w. Steamship—Dec., 1898. No. 24563 A.

Subsidies.

Subsidies for Ships. Full text of the measure for the revival of the American marine. 5000 w. Marine Rev—Dec. 22, 1898. No. 24767.

MECHANICAL ENGINEERING.

AUTOMOBILISM.

American.

Motor Vehicles in the United States To-day. A general survey of this new industry, giving manufacturers and inventors work, with gasoline, electricity and steam. Ill. 23300 w. Horseless Age—Oct., 1898. No. 24472 C.

Austrian Army.

Moto Vehicles for the Austrian Army. From *Die Reichswehr*, Vienna. On the advantages and disadvantages of these vehicles for army purposes. 1000 w. Automotor Jour—Dec., 1898. No. 24760 A.

Contest at Boston.

Practical Motocycles at Charles River Park, Boston, November 9. Hugh Dolnar. Considers the two main classes of mechanically propelled vehicles, and illustrates and describes various types and the contest at the place named. 3000 w. Am Mach—Dec. 29, 1898. No. 24917.

Electric.

The Electric Moto-Vehicle. C. E. Woods. Read before the Chicago Elec. Assn. Discusses the development, the cost, utility, possibilities as an industrial feature, &c. 1800 w. Elec, N. Y.—Nov. 30, 1898. Serial. 1st part. No. 24306.

Electric Cabs.

Electric Cabs in New York. Joseph Sachs. Information concerning the plant of the Electric Vehicle Company, with illustrations and descriptions of the cabs, and of their management. 1800 w. Harper's Wk—Dec. 10, 1898. No. 24461.

England.

Views on Automobilism. Sir David Salomons. Discusses the use of motor cars in England, the things that retard the progress, the pleasure to be derived, speed, &c. 2000 w. Automotor Jour—Nov. 15, 1898. No. 24300 A.

France.

The French Automobile Industry in 1897. Lucien Périssé. Excerpt from a paper contributed to the French Soc. of Civ. Engs. Classification of vehicles, the advantages and inconveniences, and improvements desirable. 2200 w. Automotor Jour—Dec., 1898. No. 24761 A.

Future Prospects.

The Modern Moto-Vehicle and Its Future. Excerpt from a lecture delivered at Liverpool, by Prof. Hele-Shaw. Inquires into the causes of failures of making moto-vehicles a success sixty or more years ago, when they were quite largely used, and discusses their future prospects. 1400 w. Automotor Jour—Nov. 15, 1898. No. 24303 A.

Heavy Traffic.

Excerpt from the Official Report of the Judges on the Trials of Moto Vehicles for Heavy Traffic Held in Liverpool. Gives particulars of the competition, illustrated descriptions of vehicles entered, the costs of working, and conclusions. 8500 w. Automotor Jour—Nov., 1898. No. 24453 A.

Heavy Weights.

Les Poids Lourds Concours. Illustrates and describes the vehicles that took part in the heavy weight trials at Versailles, France, and reports their performance. Also editorial. 4000 w. Automotor Jour—Nov. 15, 1898. No. 24302 A.

Petroleum Supply.

The Supply of Moto-Car Spirit or Petrol. George Herbert Little. Notes that a great majority of these vehicles use products of petroleum and discusses the facilities for a proper supply and distribution of the oil known as moto-car spirit and petrol. 1800 w. Automotor Jour—Nov. 15, 1898. No. 24301 A.

Physician's Carriages.

On the Choice of a Moto-Vehicle. Considers the choice of moto-carriages for the use of medical men. 1200 w. Automotor Jour—Dec., 1898. No. 24762 A.

Progress in 1898.

The Year's Progress in Motor Road Locomotion. A lengthy review of the progress in different countries, of all classes of vehicles, and of the factories and industries connected with their manufacture. Many illustrations. 37,000 w. Ind & Ir—Nov. 25, 1898. No. 24469 A.

Progress in Germany.

Revolution in Traffic. Adolph Schulze. Translated from *Ueber Land und Meer*. On the progress of automobile carriages in Germany. 2200 w. Chau—Jan., 1899. No. 24758 C.

Steam Omnibus.

Martyn's Locomotor Car or Steam Omnibus. Illustrates and describes one of the latest forms of steam carriages for common roads. The chief points of originality are the steering gear, the compensating gear, and the boiler. 1500 w. Engr, Lond—Dec. 2, 1898. No. 24533 A.

Steam Wagons.

Steam Driven Road Wagons. Hugh Dolnar. An illustrated detailed description of William B. Mason's carriage, and an explanation of its connection with the Stanley carriage. 2500 w. Am Mach—Dec. 1, 1898. No. 24332.

Traveling Vehicles.

Automobile Traveling Vehicles. From *La Nature*. Illustrates and describes the Jeantaud automobile carriage. 800 w. Sci Am Sup—Dec. 3, 1898. No. 24337.

HYDRAULIC ENGINEERING.

Flow.

Gauging in Hungary. (Jaugeages en Hongrie.) Joseph Péch. Describes at lenghth, with many illustrations, a new method of gauging streams in use by the Hydrographic department of the Hungarian Government. 8500 w. Ann des Ponts et Chaussées—3e. trimestre, 1898. No. 24885 E+F.

New Gaugings of the Rochester Conduit. Reviews experiments on large cast-iron and riveted plate pipe lines about 20 miles long. 1200 w. Eng Rec—Dec. 10, 1898. No. 24537.

Two Formulæ for the Permanent and Uniform Flow of Liquids. (Note sur Deux Formules Relatives à l'Ecoulement Permanent et Uniforme des Liquides.) Victor Fournié. The formulæ considered are those for cylindrical pipes and open canals, and differ somewhat from those in general use. They consider a larger number of factors and, by the suppression of the less important, become more nearly expressions of real laws of flow. 1600 w. Ann des Ponts et Chaussées—3e. trimestre, 1898. No. 24887 E+F.

Hydraulic Governor.

The Rusch-Sendtner Hydraulic Governor. From *Revue Industrielle*. Describes a new resistance or brake governor adapted for maintaining a constant velocity in any sort of a hydraulic motor. Ill. 700 w. Sci Am Sup—Dec. 24, 1898. No. 24704.

Pumps.

Recent Improvements in Centrifugal Pumps. J. Richards. Explains and illustrates the conoidal system as used for the drainage works at New Orleans. 900 w. Eng News—Dec. 1, 1898. No. 24325.

Rams.

The Durability of Cast-Iron Rams for Hydraulic Presses. "Uni." The durability of rams and the causes of their becoming rough, with means of preventing the trouble. Ill. 1800 w. Prac Engr—Nov. 25, 1898. No. 24447 A.

Turbines.

The New 2500 Horse-Power Turbines at Niagara. S. S. Knight. Illustrates and describes a pair of Geyelin-Jonval horizontal axis turbines lately installed. 600 w. Sci Am—Dec. 10, 1898. No. 24475.

MACHINE WORKS AND FOUNDRIES.

Ball Race.

The Ball Race. Mark Barr. Discusses the accuracy of ball races. 800 w. Elec Rev, Lond—Nov. 25, 1898. No. 24442 A.

Bolts.

A Chart of Bolt Strengths. Lawford H. Fry. Gives a diagram illustrative of the great amount of engineering information that can be given by the use of charts. 1200 w. Am Mach—Dec. 8, 1898. No. 24483.

Cams.

Fixture for Grinding Profile Cutters and Laying-Off Cams. A. L. De Leeuw. Description with sketch illustrating the principle of the device. 7000 w. Am Mach—Dec. 29, 1898. No. 24919.

Castings.

Patterns and Castings as Witnesses. John M. Richardson. Calls attention of young pattern makers to marks on castings and their causes. 1600 w. Am Mach—Dec. 15, 1898. No. 24618.

Porous Castings and Occluded Gases. Max H. Wickhorst. Read at the meeting of the Western Foundrymen's Assn. Explains what occluded gas is, and the troubles caused by it, dealing with the various gases separately. 4000 w. Ir Trd Rev—Dec. 29, 1898. No. 24907.

Some Recent Experience in Casting Wrought Iron. C. Vickers. An account of methods successfully used by the writer. 2000 w. Am Mach—Dec. 1, 1898. No. 24331.

Compression.

Feeding, or the Compressing of Metals. William Roxborough. Considers the influence certain brands of metal have upon castings, position of casting and related matters. 2000 w. Foundry—Dec., 1898. No. 24764.

Cores.

Core Prints. John M. Richardson. Describes the various prints used, offering suggestions. Ill. 1600 w. Foundry—Dec., 1898. No. 24763.

Drilling.

Drilling and Tapping Machine. A. H. Cleaves. Illustrated detailed description. 800 w. Am Mach—Dec. 22, 1898. No. 24698.

Drill Sharpening.

Rock Drill Sharpening Machines. Illustrates and describes the various British patents of these machines, with comments on the types. 1600 w. Col Guard—Dec. 9, 1898. No. 24643 A.

Forging Press.

Variable Power Hydraulic Forging Press. (Presse Hydraulique à Forger, à Puissance Variable.) Illustrated description of an English built machine giving three grades of pressure on the work. 800 w. La Revue Technique—Dec. 10, 1898. No. 24853 D.

Lathes.

The Choice of a Small Lathe. Joseph Horner. Gives details of the construction of the 5-in. lathe, with the writer's idea of details desirable in a machine, where only one lathe is owned, or can be accommodated. 2500 w. Mech Wld—Dec. 16, 1898. Serial. 1st part. No. 24783 A.

Machinery.

See Economics and Industry, Commerce and Trade.

Machine Tools.

A New Device for Boring, Milling and Tapping. (Ein Neues Verfahren zu Bohren, zu Fräsen, und mit Gewinde zu Verschen.) E. Capitaine. Describing and illustrating an improved portable tool arranged to be clamped to work in any part of the shop, thus avoiding the handling of heavy pieces. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 12, 1898. No. 24800 D.

See Economics and Industry, Commerce and Trade.

Melting Iron.

Experiments in Melting Iron. Edward Kirk. From a forthcoming work on "Cupola Practice." Gives opinions formerly held, describing experiments made, and results. 3500 w. Ir Trd Rev—Dec. 29, 1898. No. 24906.

Metal Mixers.

Metal Mixers and Casting Machines. E. J. W. Richards. Abstract of a paper read at meeting of West of Scotland Iron & Steel Inst. Urges the employment of a chemist, describes the practice at the Carnegie works, refers to the Uehling casting-machine and its advantages, and gives his suggestions for manner of working in Scotland. 2400 w. Col Guard—Nov. 25, 1898. No. 24426 A.

Pig Iron.

The Yard Grading of Pig Iron. William B. Phillips. Read before the Pittsburg Foundrymen's Assn., Dec. 27, 1898. Defines the various grades, and ways of grading, giving proposed improvements. 3800 w. Ir Trd Rev—Dec. 29, 1898. No. 24905.

Pulley Accident.

Pulley Accident at Fredonia, N. Y. John E. Sweet. Describes the accident, giving illustrations showing fractures. 700 w. Power—Dec., 1898. No. 24608.

Screw Threads.

Metric Screw Threads. (Metrisches Gewinde.) A general review of the subject, with especial reference to the recent convention at Zurich. A very complete and valuable bibliography is also given. 3500 w. Zeitschr de Ver Deutscher Ing—Dec. 3, 1898. No. 24809 D.

Shafting.

Do Compressed Shafts Become Curved when Keyways are Cut in Them? (Werden Comprimirte Wellen durch das Einarbeiten von Nuten Krumm?) C. Bach. Gives the results of careful tests showing the amount by which cold-rolled shafts spring when cut for keyways, with illustrations of the apparatus used. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 12, 1898. No. 24802 D.

Stay Bolts.

Stay Bolts and Braces. L. A. Caldera. Considers the tensile strain that may be allowed, the fastening of these, stiffness of sheets, &c. Ill. 2700 w. Power—Dec., 1898. No. 24610.

Wire Nail Plant.

The Portage Iron Company, Limited. Illustrates and describes a model plant at Duncansville, Pa. 2500 w. Ir Age—Dec. 15, 1898. No. 24613,

Works Management.

Machine-Shop Management in Europe and America. H. F. L. Orcutt. This paper treats of specialization vs. generalization of equipment and products. It contrasts the American policy of close concentration upon a limited range of manufacture with the European practice of turning out many diverse products from a single works, and argues the strong influence of the former cause upon higher perfection, capacity, and economy. 3400 w. Engineering Magazine—Jan., 1899. No. 24893 B.

MATERIALS OF CONSTRUCTION.

Copper.

Concerning the Influence of Heat on the Strength of Copper. (Ueber den Einfluss der Wärme auf die Festigkeitseigenschaften von Kupfer.) M. Rudeloff. A very elaborate account of the exhaustive tests made at the government testing laboratory at Charlottenburg. 12,000 w. Mitt aus den Kgl Tech Versuchanstalt—Part IV. 1898. No. 24932 G.

Rivets.

Nickel-Steel Rivets. Summary of report of Maunsel White on important experiments made at the works of the Bethlehem Iron Co., for the purpose of ascertaining the reliability and efficiency of nickel steel for general riveting, and to observe the effect of the material at different degrees of heat. Ill. 1000 w. Jour Am Soc of Nav Engs—Nov., 1898. No. 24355 H.

Testing.

Standard Methods of Testing Cast Iron. (Einheitliche Prüfungsverfahren für Gusseisen.) Prof. A. Martens. A general discussion of the methods suggested at the conferences of the International Association, with tables, diagrams and valuable data. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Nov. 26, Dec. 3, 1898. No. 24807 each D.

Permanent Deformation and Rupture of Metals. (Déformations Permanentes et Rupture des Métaux.) G. Faurie. A general description of tension tests of metals, with illustrations of machines employed, specifications of test pieces, physical phenomena in metals under tension, and a discussion of Tresca's laws. 7500 w. Revue de Mécanique—Nov., 1898. No. 24889 H.

POWER AND TRANSMISSION.

Air Compressor.

A Compound High-Duty Air Compressor. Illustrates and describes a compressor in the service of the Indianapolis Water Co., used in raising water from a series of wells. 700 w. Am Mach—Dec. 15, 1898. No. 24620.

The Rotary Blower as an Air Compressor. Frank Richards. An explanation of the loss of power inseparable from the rotary blower and seemingly fatal to its use as an air compressor. Ill. 1500 w. Am Mach—Dec. 29, 1898. No. 24918.

Crank-Effort.

Diagrams of Crank-Effort. G. H. Shepard. Explains the method of obtaining the curves. Ill. 2500 w. Sib Jour of Engng—Dec., 1898. No. 24664 C.

Dynamo Driving.

The Use of Gas Engines for Dynamo Driving. John C. Kelley. Considers the cost of gas, the main reason why these engines are not more largely used. Discusses the cost as compared with England, and other causes affecting the sales. 1000 w. Elec Wld—Dec. 31, 1898. No. 24922.

Haulage.

Compressed Air Haulage. A description of the haulage ways, the grades, the construction of the locomotives and charging apparatus, and some figures as to economies of the plant at the Coal Brook mines near Carbondale, Pa. Ill. 2500 w. Mines & Min—Dec., 1898. No. 24367 C.

Power Measurement.

Measurement of Power with the Indicator. Explains the principle upon which most indicators work, giving illustrated descriptions of various types. 2300 w. Mech Engr—Dec. 3, 1898. Serial. 1st part. No. 24675 A.

Rope-Driving.

Ropes and Rope Driving. G. H. Kenyon. Extracts from a lecture before the Yorkshire Assn. of Engs. (England). Gives the writer's views on the subject of centrifugal tension in ropes, and discusses various difficulties in rope driving. 3500 w. Mech Wld—Dec. 16, 1898. Serial. 1st part. No. 24782 A.

Water-Power Plants.

Industrial Electro-Hydraulic Installations. (Impianti Industriali Elettro idraulichi.) Carlo Gabussi. An argument for the electrical exploitation of the numerous small water-powers in Italy, containing some data of streams, etc. 1500 w. Giorn dei Lav Pubb e delle Str Ferr—Nov. 16, 1898. No. 24851 B.

Water Power and Italian Legislation. (Le Forze Idraulichi e la Legislazione Italiana.) Report of M. Vicari and R. Pinna to the 3d. National Congress of the Società Economiche. A very full discussion of the present status of the subject. In 1897 4,259,646 tons of coal were imported into Italy, yet the great water power resources of the country are barely used. Present legislative enactments make it difficult to develop this power, and the report urges the grant of concessions to corporations under certain restrictions. It is full of valuable data. 7500 w. L'Elettricità—Oct. 30, 1898. No. 24860.

SPECIAL MOTORS.

Compressed Air.

Compressed Air Applied to Traveling Motors by a New Method. W. M. Farrar. Calls attention to a recently invented method of applying compressed air to moving motors, which it is believed will obviate most of the difficulties. Ill. 1600 w. Compressed Air—Dec., 1898. No. 24580.

Gas Engine.

Planteau Balanced Vertical Gas-Engine. (Moteur vertical Equilibié Système Planteau.) Short illustrated description of a balanced vertical, one-cylinder gas engine, specially adapted for automobile vehicles. Balance is obtained by the use of a piston in each end of the cylinder, their movements being always equal and opposite. 500 w. La Revue Technique—Dec. 10, 1898. No. 24855 D.

Gas Engines. George N. Crouse. Part first describes the Otto Method. 2000 w. Yale Sci M—Nov., 1898. Serial. 1st part. No. 24419 C.

The Problem of the Gas Engine. Herbert L. Towle. Considers the present problem is to abolish the elements of uncertainty, and to this end, the paper analyzes the factors on which ignition and combustion depend, and the methods thus far employed to control them. 3500 w. Am Mach—Dec. 1, 1898. No. 24330.

Gasoline Engines.

Gasoline and Oil Engines for Pumps. Illustrated comparison of the cost of pumping small volumes of water by internal combustion engines and steam, and a description of two water-works having kerosene-engine plants. 1200 w. Eng Rec—Dec. 24, 1898. No. 24733.

The Gasoline Engine. E. W. Roberts. Briefly discusses the nature of gasoline, the advantages and uses of the gasoline engine and the principles of construction. 1500 w. Home Study—Jan., 1899. No. 24685.

STEAM ENGINEERING.

Boiler Explosion.

Boiler Explosion at Norwich. Report of the Board of Trade investigation of the explosion at the new technical schools in course of building at Norwich, Eng., with editorial comment. 6500 w. Engng—Dec. 9, 1898. No. 24640 A.

Boilers.

On the Comparative Efficiency of Water-Tube and Water-Tank Boilers. W. George Akhurst. Points out some erroneous opinions in regard to water-tube boilers, and gives the opinion that they will never surpass the water-tank boilers in point of number. 1600 w. Prac Engr—Dec. 2, 1898. No. 24561 A.

Water-Tube Boilers. (Les Chaudières à Tubes d'Eau.) G. Humber. A general illustrated description of various types of water-tube boilers with remarks upon their handling and management. 8000 w. Ann des Ponts et Chaussées—3e. trimestre, 1898. No. 24882 E+F.

Water-tube Boilers a Necessity.—A War Lesson. J. K. Robison. Discusses the conditions of the late war, and what is required to properly meet them. Considers the particulars of design in water-tube boilers required for efficiency. 5000 w. Jour Am Soc of Nav Engs —Nov., 1898. No. 24354 H.

Boiler Setting.

How to Set a Wood-Consuming Boiler. Considers the best methods for wood-consuming boilers. 1200 w. Min & Sci Pr—Dec. 24, 1898. No. 24911.

Chimney.

New York's New Chimney. Illustrates and describes a brick chimney 353 ft. high for the 70,000 H. P. Station of the Metropolitan St. Ry. Co. 1300 w. Eng Rec—Dec. 17, 1898. No. 24602.

Combustion.

The "Econometer." H. M. Kebby. Considers the production of heat from a given combustible, and gives an illustrated description of the apparatus named, which indicates continuously the exact percentage of carbonic acid contained in the escaping products of combustion. Gives also the report of the Franklin Inst. on this instrument. 4300 w. Jour Assn of Engng Soc's—Nov., 1898. No. 24710 C.

Compound Engine.

Compound Engine in the Power-House of the Budapest Electric Railway. Brief illustrated decription of this stationary engine. From the *Zeitschrift der Vereines Deutscher Ingenieure.* 350 w. Eng News—Dec. 1, 1898. No. 24324.

Compression.

On the Compression of Steam in Engines. Is it Economical in Practice? Gives a report of Belgian, American and German experiments, with the conclusion that a certain amount of compression is desirable and economical. 3000 w. Engr, Lond—Nov. 25, 1898. No. 24432 A.

Engineering Plants.

Modern Practice in the Engineering Plants of Large Buildings. William H. Bryan. Extract from an address delivered before the St. Louis Chapter of the Am. Inst. of Archt's. An outline of the writer's views as to what is good practice. 2000 w. Am Arch—Dec. 24, 1898. No. 24765.

Feed Water Purification.

Purification of Boiler Feed Waters by Heat. (Epuration des Eaux d'Alimentation des Chaudières par la Chaleur.) A general description of methods and apparatus, illustrated with details of the Buron apparatus, with data of heat required for precipitation of calcareous matters. 1800 w. Le Génie Civil—Dec. 3, 1898. No. 24865 D.

Firing.

Fuel and Furnaces. C. E. Lake. Discusses means of reducing waste, especially by the labor employed. 1200 w. Elec Engng—Dec., 1898. No. 24714.

Flow of Steam.

Formulæ for Flow of Steam Through Pipes. R. C. Carpenter. Investigations, with explanations of tables given. 2200 w. Sib Jour of Engng—Dec., 1898. No. 24666 C.

Friction Brake.

Prony's Friction Brake. William Barnet Le Van. From *Power and Transmission.* Gives briefly the history of this invention with description of the brake and the recent improvements. 2000 w. Mech Wld—Dec. 16, 1898. No. 24781 A.

Mechanical Draft.

The Cost of Mechanical Draft Plant. Walter B. Snow. Discusses the primary cost of the plant and the fixed charges as compared with those incident in the employment of a chimney. 1800 w. Ir Age—Dec. 1, 1898. No. 24334.

Piping.

The Design of Piping for Electric Power Houses. Illustrated description of the best methods of piping and of faults to be avoided. 6000 w. Eng Rec—Dec. 17, 1898. No. 24603.

Smoke.

Smoke. Editorial discussion of the recent agitation in England over the smoke prevention question. 2000 w. Engr, Lond—Dec. 9, 1898. No. 24650 A.

The Law and Practice of Smoke Prevention. Comments on the agitation of this subject by Sir W. B. Richmond, and the results of experiments made for the purpose of furnishing a basis of comparison. 2300 w. Jour Gas Lgt—Dec. 6, 1898. No. 24614 A.

Standards.

Engine Proportions. James Christie. Reasons why it is difficult to make them always conform to an arbitrary standard. Especially considers shafts and bearings of engines. 1200 w. Am Mach—Dec. 15, 1898. No. 24619.

Superheated Steam.

Superheated Steam and Its Application on Steam Engines. Paul Schou. Abstract from a paper read before the Northern Soc. of Elec. Engs., England. Describes the Schmidt tandem compound engine and the superheater. 2200 w. Ind & Ir—Dec. 9, 1898. No. 24637 A.

Thermal Efficiency.

Thermal Efficiency of Steam-Engines. R. H. Thurston. Abstract and summary of conclusions of the committee of the British Inst. of Civ. Engs. in their report on this subject. 1600 w. Science—Dec. 2, 1898. No. 24378.

Valve.

Intercepting Valve for Compound Locomotives. Illustrates and describes the intercepting valve for the Cooke compound, the object of which is to convert an engine from a compound to a simple, and to permit the engine to run simple for any length of time. 700 w. Loc Engng—Dec., 1898. No. 24399 C.

MISCELLANY.

Bicycles.

On the Steering of the Bicycle. G. T. McCaw. An investigation of the causes which affect steering, with a view to determining the best design of the steering head. 2000 w. Engr, Lond—Dec. 9, 1898. No. 24648 A.

Relation between Forward Movement and Lateral Inclination of a Bicycle. (Relation qui

Existe, dans la Bicyclette roulant sur un Sol Horizontal, entre la Mouvement de Progression et le Mouvement d'Inclinaison.) J. Boussinesq. A mathematical study of this relation which is finally defined in a differential equation of the second degree. 1200 w. Comptes Rendus—Nov. 28, 1898. No. 24850 D.

China and Japan.

Observations of an American Engineer in China and Japan. August C. Christensen. The condition of machine works in these countries is discussed, and other things observed by the writer. 2200 w. Am Mach—Dec. 15, 1898. No. 24621.

Flying Machines.

Flying Machines and Ordnance. Hiram Maxim. Delivered before the Engng. Soc. of Columbia Univ. of the City of N. Y. Relates experiments with flying machines, and his work on rapid-firing guns and smokeless powder. 2500 w. Sci Am—Dec. 24, 1898. No. 24700.

Mechanical Units.

Notes on the Definitions of Some Mechanical Units. William Kent. Read before the session of Mech. Science and Engng. of the Am. Assn. for the Adv. of Science, at Boston. Discusses the difference of opinion existing between physicists and engineers in regard to definitions of commonly used terms. 1800 w. Eng News—Dec. 1, 1898. No. 24328.

Refrigeration.

Ammonia Absorption System of Refrigeration. H. F. Stanley. Considers the construction of the generator, and separator, the importance of the economizer, &c. 2400 w. Ice & Refrig—Dec., 1898. Serial. 1st part. No. 24393 C.

Russia.

Engineering in Russia and the Use of Naphtha for Fuel in Russia. Alexis Gatzook and Stephen Goulishambaroff. Information concerning the mechanical industries, fuel, &c. Ill. 3000 w. Power—Dec , 1898. No. 24609.

Slide Rule.

The Slide Rule. Edwin H. Lockwood. Describes the slide rule and its use. 2000 w. Yale Sci M—Nov., 1898. No. 24418 C.

Tire Repairing.

Practical Hints from a Tire-Repair Shop. B. F. Fells. Discusses the treatment of punctures, and the methods of sewing tires. Ill. 1000 w. Ind Rub Wld—Dec. 1, 1898. No. 24344 D.

MILITARY ENGINEERING.

Aluminum.

Use of Aluminum in Warfare by the Armies and Navies of the World. From *The Aluminum World.* Discusses how aluminum could be used to advantage. 2200 w. Sci Am Sup—Dec. 17, 1898. No. 24575.

American Navy.

Effect of the Late War on the American Navy. Editorial discussing the effect on war material, gunnery, &c. 1500 w. Engr, Lond—Dec. 16, 1898. No. 24743 A.

Armor Plates.

Beardmore Process Armor-Plates. Brief report of a severe test of plates supplied to the Danish Government by Messrs. Beardmore, Glasgow. 700 w. Engr, Lond—Nov. 25, 1898. No. 24482 A.

Army Supply.

Our Army Supply Departments and the Need of a General Staff. John H. Parker. Discusses the quartermaster, commissary, and ordnance departments, and their work in the war with Spain, and offers recommendations tending toward the improvement of that military service. 9300 w. Am Rev of Revs—Dec., 1898. No. 24389 C.

Artillery.

The Artillery in Battle. John P. Wisser. A discussion of tactics considering the attack, the defense, night combats, rapid-fire guns, &c. 3800 w. Jour of U. S. Art—July, Aug., 1898. No. 24376 D.

Battleship.

The First-Class Battleship "Maine." An accurate engraving, with description of the new battleship bearing this name. 1800 w. Sci Am—Dec. 3, 1898. No. 24336.

Battleship Plant.

Electrical Equipment of the U. S. Battleship "Oregon." Alex. J. Dickie. Gives a summary of the features of the ship with detailed description of her electrical equipment. Ill. 1700 w. Am Elect'n—Dec., 1898. No. 24474.

British Navy.

Naval Expenditure. Editorial discussion of the Board of Trade return for 1897, giving comparison with other countries, and information of interest. 2000 w. Engng—Dec. 16, 1898. No. 24746 A.

Classification.

Classification of War Ships and Torpedo Boats. J. Foster Symes. Explains on what classification depends, and describes the various types. 1800 w. Yale Sci M—Nov., 1898. No. 24420 C.

Cruiser.

The Argentine Armored Cruiser "General Belgrano." Illustrates and briefly describes this sister ship to the "Christobal Colon." 600 w. Sci Am Sup—Dec. 17, 1898. No. 24574.

Engineering in the Navy.

Electrical and Engineering Work in the Navy During the War. W. D. Weaver. Reviews the various applications that would add to the efficiency and general comfort of a man-of-war, citing successful applications and those that have failed or not yet been tried. 1500 w. Elec Eng, N. Y.—Dec. 22, 1898. No. 24672.

Gibraltar.

Defensive Works in Progress at Gibraltar.

Works for the extension of moles and dock accommodation, and strengthening of the land defences are in progress. Notes on these and other works are given. 1400 w. Engr, Lond—Dec. 2, 1898. No. 24531 A.

Gun Carriages.

The Development of Carriages for Rapid-Fire Guns. (Die Entwickelung der Schnellfeuer-Feldlaffeten.) J. Castner. With details of carriages, and reproductions of photographs of some of the latest forms of German field artillery. 3500 w. Stahl und Eisen—Dec. 1, 1898. No 24928 D.

Naval Corps.

The necessity for a Naval Electrical Engineer Corps. F. W. Roller. Arguments in favor of electric motors on American battle-ships, and the need of a corps of electrical engineers for the navy. 12,000 w. Elec Eng, N. Y.—Dec. 29, 1898. No. 24937.

Naval Engineers.

The Fighting Engineers at Santiago. Arthur Warren A well illustrated account of the excellent work of the U. S. naval Engineers in the Santiago campaign and in the great battle with the Spanish squadron. The author shows how large a part was played by the engineers, who should no longer be considered as non-combatants, and how it was through their efforts that the brilliant victory was won. The article contains numerous intimate details of the life of the engineers at sea, the work of engine and fire-room forces in battle, and speaks of the condition of the motive power of some of the U. S. vessels during the engagement. It is written in vigorous and picturesque style. 4200 w. Engineering Magazine—Jan., 1899. No. 24892 B.

Naval Machinery.

Material for Naval Machinery. A copy of the specifications issued by the Bureau of Steam Engineering of the Navy Dept., for the inspection of material for use in the construction of machinery for the U. S. Navy. 4800 w. Ir Age—Dec. 8, 1898. No. 24462.

With the Machinery of a War-Ship During Action. B. S. Notes on the conditions of the engine-room during an engagement, showing that there is room for improvement in the arrangement of machinery. 1600 w. Prac Engr—Dec. 9, 1898. No. 24776 A.

Naval Personnel.

The Reorganization of the Naval Personnel. A symposium including 1. The suggestion of a solution, by Francis H. Wilson ; 2. The genesis of the personnel bill, by Theodore Roosevelt; 3. A line officer's view, by John W. Philip ; 4. An engineer officer's view, by George W. Melville ; and 5. From the standpoint of the people, by George Edmund Foss. 20,000 w. N Am Rev—Dec., 1898. No. 24385 D.

Navies.

Comparative Strength of the World's Navies. A comparison to show the position of the U. S. in naval strength. Ill. 2300 w. Sci Am—Dec. 31, 1898. No. 24941.

Navy Engineering.

Applied Science in the Navy. R. H. Thurston. Comment on information in the report of the Chief of the Bureau of Steam Engng. of the Navy Dept. of the U. S. on the work performed during the war with Spain. 1300 w. Science—Dec. 9, 1898. No. 24476.

Ordnance.

Forthcoming Improvements in United States Naval Ordnance. G. L. Carden. Discusses changes to be made in guns and mounts and in the make-up of the ships' batteries. 2000 w. Sci Am—Dec. 17, 1898. No. 24572.

Shell.

The Manufacture of Shell for the United States Navy. Rudolph E. Bruckner. Illustrates and describes the work, showing the exactness necessary, and the describing method of inspection. Considers the manufacture of the 5-inch cast iron shell. 2000 w. Am Mach—Dec. 29, 1898. No. 24916.

Steam.

Steam in the Navy and Naval Engineering. Abstracts from the report of Engineer-in-Chief of the Navy, Commodore G. W. Melville, showing the part played by the mechanical engineer and machine-constructor in modern naval wars. 5000 w. Sib Jour of Engng—Dec., 1898. No. 24665 C.

Submarine Boats.

Submarine Torpedo Boats: Their Influence on Torpedo Boat Architecture and Value in Warfare. William H. Jaques. Read at session of the Inst. of Naval Archt's., London. Reviews the history of past experience, describing the boats built under Mr. Holland's direction, also the "Plunger" and "Holland." Ill. 3300 w. Marine Engng—Dec., 1898. No. 24545 C.

Torpedo Boats.

Electrical Propulsion for Torpedo Boats. Charles T. Child. A discussion of the present possibilities of electric torpedo boats, showing them to be fitted for satisfactory work, and stating their advantages. 2400 w. Jour of Am Soc of Nav Engs—Nov., 1898. No. 24351 H.

Full Details of Sixteen Torpedo Boats to be Built for the United States Government. 2400 w. Engng Mech—Nov., 1898. No. 24396 C.

The Torpedo-Boat Family. (La Famiglia Torpediniera.) Lieut. G. Roncagli. An extended history of torpedo and torpedo-boat warfare with much interesting information concerning early torpedo exploits. The author argues for the superiority of the gun over all other weapons. He believes the extension of ranges and powers of artillery minimizes the effectiveness of torpedo-boats discharging automobile torpedoes, as these are essentially close-range weapons. The paper is remarkable not only for its argument but for the literary style it displays. 11,000 w. Rivista Marittima—Nov., 1898. No. 24875 H.

War Study.

Introduction to the Study of the War between Turkey and Greece. C. F. von der Goltz. Discusses the main object and original plans of campaign of the Turks. 3000 w. Jour of U. S. Art—July-Aug., 1898. Serial. 1st part. No. 24377 D.

MINING AND METALLURGY.

COAL AND COKE.

Coal Dust.

Rendering Coal Dust Non-Dangerous in the Saar District. From an official report by Bergassessor Dröge, Saarbrücken. The removing of the dust in this colliery was proved impracticable, and the methods of damping are described, and the advantages and disadvantages discussed. 6500 w. Col Guard—Dec. 9, 1898. No. 24642 A.

Coal Testing.

Coal Testing and Analysis. Camille Matignon. From a communication to the Second International Congress of Applied Chemistry. Reviews the factors which intervene in the examination of a coal, showing the advantage of introducing the calorific power into the clauses of a coal contract, and the utility of the Mahler shell. 3000 w. Col Guard—Nov. 25, 1898. No. 24429 A.

Coking.

The Coking of Inferior Coals with the Aid of Pressing Machines. Partly translated from *Stahl und Eisen* and partly gathered from the records of the English Patent Office. Briefly notes the methods tried, and the degree of success, with illustrated description of various machines. 4000 w. Ir & Coal Trds Rev—Dec. 16, 1898. No. 24735 A.

The Coking of Lean Coals. (Ueber die Verkokung Magerer Steinkohlen.) O. Simmersbach. A description of a method of compressing coal slack into coherent masses for coking in special ovens. 2500 w. Stahl und Eisen—Dec. 1, 1898. No. 24930 D.

Consumption.

Coal and Coke Consumption for Different Purposes in France, Belgium and Germany. Statistics showing the increase and activity in these industries. 900 w. Col Guard—Dec. 2, 1898. No. 24522 A.

Indian Coals.

The Distribution, Methods of Working, and quality of Indian Coals. Information on the occurrence and working of Indian Coal, taken from the report of W. R. Durstan to the Imperial Inst. 3300 w. Ir & Coal Trds Rev—Dec. 2, 1898. No. 24569 A.

Scotch Coals.

Scotch Coals in the Manufacture of Iron and Steel. F. W. Paul. Abstract of a paper read before the West of Scotland Iron and Steel Inst. Gives results of analyses and some practical results of the consumption of fuel in coal-fired heating furnaces and the boiler-evaporative duty. 2800 w. Ir & Coal Trds Rev—Nov 25, 1898. No. 24424 A.

Subsidence.

Subsidence Due to Coal Workings. Abstract of a paper by S. R. Kay, read at meeting of the Inst. of Civ. Engs., England. In designing works for mining districts the importance of knowing the principles of subsidence, the approximation to the area necessary to be left unworked, and how the design may be suited to the possibility of the coal being worked without leaving solid pillars for support. 1400 w. Col Guard—Dec. 2, 1898. No 24523 A.

Washington.

Coal Mining in Washington. The situation and particulars in relation to the history and methods of working of the mines of the Northern Pacific Coal Co. at Roslyn and the mines of Kittitas County. Ill. 3000 w. Mines & Min—Dec., 1898. No. 24366 C.

COPPER.

British Columbia.

Copper Mining at Kamloops, B. C. W. M. Wade. An account of the discovery and the value of the deposits. 900 w. Eng & Min Jour —Dec. 10, 1898. No. 24512.

Copper Deposits.

A New Copper Region. J. C. Kennedy. Report of the deposits on or near the boundary between Wyoming and Colorado. Briefly deribes some of the claims. 2200 w. Min Rept —Dec. 1, 1898. No. 24460.

Copper Ore.

Copper Traces in Bucks and Montgomery Counties. Benjamin Smith Lyman. A record of the location and mode of occurrence of these traces, which are not workable, with the idea of preventing waste of money on deposits practically worthless. Map. 2300 w. Jour Fr Inst —Dec., 1898. No. 24465 D.

Smelting.

Copper Smelting in Wales. W. Terrill. Gives the operations as outlined in Percy's "Metallurgy of Copper," and describes the modifications which have been adopted in the present practice. 3300 w. Eng & Min Jour—Dec. 3, 1898. No. 24400.

GOLD AND SILVER.

Alaska.

The Yukon Country. P. T. Rowe. Abstract of a lecture delivered at Sitka, Alaska. An account of the changes so rapidly wrought, and of the mining conditions and general outlook. 4500 w. Chau—Jan., 1899. No. 24757 C.

Butte, Montana.

The Mining Industry of Butte, Montana. Wascott. Describes the location and the working of the silver and copper mines. Ill. 2700 w. Min & Sci Pr—Dec. 3, 1898. No. 24478.

Colorado.

Mines of the La Plata Mountains, Colorado. R. W. Petre. Describes the location, geology, and mines. Ill. 1400 w. Eng & Min Jour—Dec. 3, 1898. No. 24401.

Concentration.

An Improved Blanket-Table. Thomas White. Before the Australasian Inst. of Min. Engs. Gives a description of improvements for simplifying the working of blanket-tables, and supplying a cheap and easily worked concentrator. Also discussion. Ill. 2200 w. Can Min Rev—Nov. 30, 1898. No. 24416 C.

A Means of Economizing Water in Concentration. Edward H. Johnson. Brief illustrated description of apparatus and method. 700 w. Jour of Chem & Met Soc of S. Africa—Oct., 1898. No. 24504 E.

Crushing.

Dry Crushing at a South African Gold Mine. (Luipaard's Vlei Estate and G. M. Co., Ltd.) George H. Furner. Describes the process and gives points in favor of dry crushing. Ill. 1400 w. Min & Sci Pr—Dec. 10, 1898. No. 24581.

Notes on Dry and Wet Crushing. Frank Merricks. Read before the Inst. of Min. and Met., London. A discussion of the best treatment for different kinds of ores. 1800 w. Col Guard—Dec. 9, 1898. No. 24645 A.

Cyanide.

Some Notes on the Recovery of Gold from Cyanide Solutions. Sherard Cowper-Coles. Reports results obtained from gold cyanide solutions of varying strengths with aluminum cathodes and iron anodes. 1600 w. Min & Sci Pr—Nov. 26, 1898. No. 24340.

Gold Fields.

One of the World's Gold Fields—The Silver Peak Mines. S. A. Knapp. An account of these mines in Nevada, whose recent extensive developments have attracted attention. 1500 w. Min & Sci Pr—Nov. 26, 1898. No. 24341.

The Alaskan Gold Fields and the Opportunities They Offer for Capital and Labor. Samuel C. Dunham. Report of recent investigations in these mining districts, showing what progress is being made, and the need of taking every precaution in going to this region. 23500 w. Bull of U. S. Dept. of Labor—Nov., 1898. No. 24348 D.

The Gippsland Gold Fields, Victoria. H. Herman. A brief description of the relations of the silurian and some of the later formations in the lower portion of the Mitchell River Valley, with some probable reasons for the difference in their metalliferous contents. 4200 w. Aust Min Stand—Nov. 3, 1898. No. 24457 B.

Gold Ores.

Mining and Milling Gold Ores in Western Australia. H. C. Hoover. A description of this gold field, the mining companies, mines, milling, costs of working, etc. 3300 w. Eng & Min Jour—Dec. 17, 1898. No. 24615.

Gold Thefts.

Gold Thefts and Illicit Gold Buying on the Rand. A. von Dessauer. Considers measures for overcoming this evil. 2000 w. Jour of Chem & Met Soc of S. Africa—Oct., 1898. No 24507 E.

Gold Veins.

Gold Veins in the San Diego Region. Arthur Lakes. Describes mine camps among orange groves and within view of the Yuma Desert and Death Valley. 1200 w. Mines & Min—Dec., 1898. No. 24370 C.

Mine Fuel.

Fuel at the Caylloma Mines, Peru. Bernard Hunt. Abstract of paper read before the Inst. of Min. & Met., London. The fuel used at these silver mines, the cost, and purposes for which it is used. 1000 w. Eng & Min Jour—Dec. 17, 1898. No. 24616.

Precious Metals.

The Mining and Minting of Gold and Silver. Alexander E. Outerbridge, Jr. A review of the last thirty years, the processes recently employed, coining, etc. 6000 w. Jour Fr Inst—Dec., 1898. No. 24464 D.

Precipitation.

A Zinc Process for Precipitating Gold from Weak Solutions. T. L. Carter. A valuable contribution to the question of zinc or electrical precipitation. Discussion opened and to be continued at next meeting. 3500 w. Jour of Chem & Met Soc of S. Africa—Oct., 1898. No. 24505 E.

Silver Field.

A New Australian Silver Field. John Plummer. Brief account of recent discoveries in New South Wales. 600 w. Eng & Min Jour—Dec. 10, 1898. No. 24513.

Slimes.

Discrepancies in Slime Treatment. W. A. Caldecott. Continued discussion of Mr. Caldecott's paper, with the writer's reply. 3000 w. Jour of Chem & Met Soc of S. Africa. Oct., 1898. No. 24506 E.

Slimes Treatment in Montana. Matt W. Alderson. Describes an agitation system where flocculation or coagulation and subsequent settling of the slimes are secured, and the gold afterwards precipitated on zinc shavings. In use at the Schmidt & John's mill, at Silver Star, Montana. 1000 w. Eng & Min Jour—Dec. 24, 1898. No. 24771.

Smelting.

The Smelting of Gold and Silver Ores in British Columbia. A statement of the situation of the smelting business in British Columbia, with a discussion of the remedies. 2000 w. Can Min Rev—Nov. 30, 1898. No. 24414 C.

Victoria.

Mining in Victoria. An interesting account of this mining region of Australia, illustrating the primitive methods of alluvial gold mining and extraction, and the progress in methods. 2000 w. Aust Min Stand—Nov. 10, 1898. Serial. 1st part. No. 24655 B.

IRON AND STEEL.

Annealed Steel.

Brittleness Produced in Soft Steel by Annealing. John Edward Stead. Read before the Iron and Steel Inst., at Stockholm. Discusses this peculiarity, its cause and how to prevent it. Ill. 6400 w. Jour Am Soc of Nav Engs—Nov., 1898. No. 24352 H.

Arctic Ores.

Mining the Iron Ores of Arctic Europe. David A. Louis. This interesting article describes the mines and mining methods of the Aktiebolaget Gellivare Malmfält in northern Sweden. The mines are located within the Arctic circle, and work the colossal ore deposits of that region. The mines are generally open cuts and the ore very hard, dynamite being used to blast it out. Highly modern methods are used, the hauling being accomplished by electric locomotives in most cases. Two maps and many fine illustrations accompany the article. 3700 w. Engineering Magazine—Jan., 1899. No. 24898 B.

Basic Steel.

The Basic Open-Hearth Process in Westphalia. (Der Basische Martin process in Westfalen.) Karl Johansson. A general account of the basic open-hearth practice, with data as to the product and methods. Two articles. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 12, 19, 1898. No. 24823 each B.

Blast Furnaces.

Blast Furnaces December 1, 1898. Tabulated statement of the number and capacity of furnaces in and out of blast in the United States. 1200 w. Am Mfr & Ir Wld—Dec. 9, 1898. No. 24547.

The Blast Furnace as a Source of Power. Horace Allen. From a paper read before the South Staffordshire Inst. of Iron and Steel Works' Managers. Discusses steps in economic progress, especially the use of waste gases. 4500 w. Col Guard—Dec. 16, 1898. No. 24739 A.

Brinell's Chart.

Brinell's Chart of Changes of Fracture and Carbon in Steel. A graphical representation of changes in steel containing 75% of carbon while heating and cooling, with description and rules for treating steel. 1600 w. Eng & Min Jour—Dec. 24, 1898. No. 24770.

Convention.

The General Convention of the Society of German Iron Masters at Düsseldorf. (Die Haupsversammlung des Vereines Deutscher Eisenhütten leute zu Düsseldorf am 23 Oktober, 1898.) A very full report of the proceedings at this important meeting, with abstracts of the papers. Two articles. 10,000 w. Zeitschr d Ver Deutscher Ing—Nov. 19, 26, 1898. No. 24804 each D.

Gun Iron.

Making of Gun Iron and Semi-Steel. Titus Ulke. Gives results of recent practice in the foundries of the United States. 3000 w. Ir Trd Rev—Dec. 1, 1898. No. 24342.

Iron and Steel.

The Metallurgy of Iron and Steel. A. Humbolt-Sexton. Part first discusses the importance of iron, chemical and physical properties, magnetism, iron oxides, &c. 2700 w. Mech Engr—Nov. 26, 1898. Serial. 1st part. No. 24654 A.

Iron Ores.

The World's Chief Deposits of High-Class Iron Ores. An account of the chief iron-ore deposits of the world with illustrations of the workings. 3000 w. Ir & Coal Trds Rev—Nov. 18, 1898. No. 24322 A.

Iron Trade.

The American Iron Trade in Ireland. Willard S. Mattox. Information relating to the trade in Belfast. 1500 w. Ir Age—Dec. 1, 1898. No. 24333.

Pig Iron.

The Costs of Pig Iron in Relation to the Ore. Walter J. May. Considers the reasons why America can deliver pig-iron in England at a lower price than the British product, and offers suggestions to mine owners and iron smelters. 900 w. Mech Wld—Dec. 2, 1898. No. 24555 A.

The Cost of Producing Pig Iron in Alabama. William B. Phillips. From advance sheets of "Iron-Making in Alabama." Statistics of cost of raw material, and of manufacture, with related matter of interest. 2500 w. Am Mfr & Ir Wld—Dec. 2, 1898. No. 24470.

See Economics and Industry, Commerce and Trade.

Rolling Mills.

Progress in Rolling Mill Construction. (Die Fortschritte in den Walzwerkseinrichtungen.) Max Meier. A long paper before the Verein Deutscher Eisenhüttenleute, describing the rolling mills at Micheville. Interesting data about electric driving are given. 4500. Stahl und Eisen—Nov. 15, 1898. No. 24927 D.

The Sack Universal Rolling Mill for Beams. (Sacksches Universal-Trägerwalzwerk.) A description of an improved form of mill with both vertical and horizontal rolls, by use of which I beams of various sizes may be rolled. 1200 w. 1 plate. Stahl und Eisen—Dec. 1, 1898. No. 24929 D.

Russian Iron.

See Economics and Industry, Commerce and Trade.

MINING.

Air Doors.

Automatic Colliery Air Doors. Illustrates and describes automatic doors, arranged to remain closed except when trucks are required to pass. 350 w. Engr, Lond—Dec. 2, 1898. No. 24529 A.

Dynamite.

The Handling of Dynamite. Points from the report of mine inspector Byrne of Montana. 1400 w. Min & Sci Pr—Dec. 17, 1898. No. 24695.

Explosives.

Explosives—Ancient and Modern. W. J. Orsman. Lecture delivered at the Wigan Mining School. Discusses the action of various explosives, the progress, and their use in mining and in purposes of war. 1200 w. Col Guard—Dec. 9, 1898. No. 24646 A.

The Position of Safety Explosives Abroad. Translated and abridged from the *Annales des Mines de Belgique*. Defines what is understood by a "safety explosive," and reviews what has been done to determine whether given explosives satisfy the conditions. 2100 w. Ir & Coal Trds Rev—Dec. 2, 1898. Serial. 1st part. No. 24570 A.

Fans.

The Fan. C. H. Innes. Gives an outline of the experiments conducted by the Prussian Mining Commission in 1884, and gives illustrated descriptions of various types. 2000 w. Prac Eng—Nov. 18, 1898. No. 24310 A.

Firedamp.

The Firedamp and Coal Dust Explosions in 1897. (Die im Jahre 1897 Erfolgten Schlagwetter and Kohlenstaub Explosionen.) With especial reference to the Westphalia district, giving details of the most important instances. 3500 w. Glückauf—Nov. 12, 1898. No. 24825 B.

Flooded Workings.

A Danger in Flooded Workings. Sketches a condition of things with regard to magnetically hinged surveys made in the half century of years between 1790 and 1840, and comments on the dangers that may now exist. 3500 w. Col Guard—Dec. 9, 1898. No. 24647 A.

Indicators.

Notes on Indicators, Feeders, etc. W. Pearce. Results of observations in prospecting. Ill. 1800 w. Aust Min Stand—Nov. 10, 1898. No. 24656 B.

Life Saving.

Methods of Life Saving in Mining. (Das Rettungswesen im Bergbaubetriebe.) H. Rössner. Especially devoted to the systematic method used in the Ostrau-Karwin coal district, describing apparatus, precautions and the very complete system of signals. 6000 w. Glückauf—Dec. 10, 1898. No. 24827 B.

Management.

Mine Management in the Kanawha Valley. Carl Schotz. Read before the West Virginia Coal Exchange. Discusses particularly economical methods of working. 2000 w. Mines & Min—Dec., 1898. No. 24371 C.

Mine Disasters.

Fatal Disasters in the Prussian and British Coal Mines in 1897. (Die Tödtliche Unfälle im Preussischen und Britischen Steinkohlen bergbau wahrend des Jahres 1897.) With comparative tables for preceding years, and various districts. 3000 w. Glückauf—Nov. 12, 1898. No. 24824 B.

Umpire Mine Disaster. William Seddon. A description of the work of rescue; also the report to the governor by Robert Brownlee, Chief of Bureau of Mines. 3000 w. Mines & Min—Dec., 1898. No. 24369 C.

Mine Timber.

The Hasselmann Pickling Process for Mine Timber. Max Krause. From a paper read before the Munich Bergmannstag. Considers how industries that use wood, especially the mining interest, can best and longest maintain it in a condition fit for use. 2500 w. Col Guard—Dec. 2, 1898. No. 24521 A.

Mine Valuation.

Mine Valuation from an Investor's Standpoint. A discussion of methods of approximating the present value of a mine. 1600 w. Can Min Rev—Nov. 30, 1898. No. 24415 C.

The Examination and Valuation of Mines. Alfred Harper Curtis. Abstract of paper contributed to the New Zealand Inst. of Min. Engs. A summary of the points in mine examinations on which the writer laid especial stress, with brief report of discussion. 1600 w. N. Z. Mines Rec—Oct. 17, 1898. No. 24423 B.

Pumping Plant.

Electric Underground Drainage Plant of 800 Horse Power. (Elektrischer Autrieb einer Unterirdischen Wasserhaltung von 800 P. S.) O. Lasche. A very full account of the electric pumping plant of the "Maria," "Anna," and "Steinbank" mines at Höntrop near Bochum, Westphalia. 4500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Dec. 3, 1898. No. 24808 D.

Timbering.

Timbering and Supporting Underground Workings. George L. Kerr. Abstract of paper read at a general meeting of the Mining Inst. of Scotland. Discusses timbering and its cost, steel and iron supports, brick walls and girders, and strength and preservation of timber. 3500 w. Ir & Coal Trds Rev—Dec. 16, 1898. No. 24736 A.

MISCELLANY.

Aluminum.

Aluminum on Its Mettle. A lengthy illustrated description of the works of the British Aluminum company, with information of this metal and its usefulness. 10800 w. Commerce—Dec. 14, 1898. No. 24726 A.

British Law.

Mines and Minerals Under and Adjacent to Waterworks. A statement of British law and report of cases. 3000 w. Col Guard—Dec. 9, 1898. No. 24644 A.

Cobalt.

The Treatment of Cobalt and Other Similar Ores. Walter J. May. The importance of classifying the material, and the need of securing the ore in the best condition possible. Gives suggestions for economical treatment. 1600 w. Col Guard—Nov. 25, 1898. No. 24427 A.

Mica.

Mining and Marketing Mica. Illustrates an East India mica mine, and the preparation of the plates, giving information relating to this product. 1200 w. Min & Sci Pr—Nov. 26, 1898. No. 24339

Mineral Exhibit.

Minerals and Mining at the Omaha Exposition. Marcus Benjamin. An interesting description of this exhibit showing the mineral wealth of the United States. 2800 w. Eng & Min Jour—Dec. 10, 1898. No. 24510.

Mineral Output.

The Mineral Output of the United Kingdom. Particulars concerning each kind of mineral, as given in report of Dr. Foster. 4000 w. Col Guard—Nov. 25, 1898. No. 24425 A.

Nickel.

Nickel Deposits Near Riddles, Oregon. W.

L. Austin. Abstract of paper read before the Colorado Scientific Society. Relates circumstances of the discovery and describes the deposits. 1000 w. Mines & Min—Dec., 1898. No. 24372 C.

Salt.

Louisiana Salt Resources. A. F. Lucas. An account of the discovery and working of deposits of rock salt of great purity in a series of islands on the Gulf Coast. 3300 w. Am Mfr & Ir Wld—Dec. 23, 1898. No. 24766.

Smelting.

Smelting in Germany. Henry Watson. Describes the process of smelting zinc-lead ores, as carried on at the Herzog Julius and Frau Sophien works, situated on the borders of the Harz Mountains. 1200 w. Aust Min Stand—Nov. 3, 1898. No. 24456 B.

Tin.

The Malay Tin Industry. Shows this to be by far the largest tin producing country in the world, and describes the deposits, mining, etc. 3000 w. Ir Age—Dec. 8, 1898. No. 24463.

Tasmanian Tin Deposits. H. Grant. The history of tin mining on the Blue Tier formations. 2000 w. Aust Min Stand—Nov. 17, 1898. No. 24658 B.

The Herberton Tin-Fields. W. S. Dowel, in the *Brisbane Courier*. Information concerning these lode tin deposits in Queensland. 1200 w. Aust Min Stand—Nov. 17, 1898. Serial. 1st part. No. 24657 B.

Turquoise.

A Turquoise Deposit in Mohave County, Arizona. A. B. Frenzel. An account of a deposit uncovered in Aug., 1898. 700 w. Eng & Min Jour—Dec. 10, 1898. No. 24511.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Accounts.

The Balance-Sheet. J. H. Brearley. Read at meeting of the Manchester Dist. Inst. of Gas Engs. Considers the methods and their faults and the various items. 3300 w. Jour Gas Lgt—Nov. 29, 1898. No. 24480 A.

Acetylene.

Acetylene Gas Generator. Sketches with brief description of Exley's acetylene gas generator. The form of construction is what is known as a displacement holder. 350 w. Engr, Lond—Dec. 2, 1898. No. 24534 A.

Acetylene Regulations and Insurance. Copy of the regulations recently adopted by the fire department of New York City, for the transportation, sale and use of calcium carbide. 1200 w. Met Work—Dec. 10, 1898. No. 24503.

Acetylene v. Ethylene. An explanation of the present state of knowledge on the subject of carbides and the gas ethylene, with a comparison of its illuminating power with acetylene. 1500 w. Engr, Lond—Dec. 16, 1898. No. 24741 A.

Town Lighting with Acetylene. Results at Wabash (Ind.), New Milford (Conn.), Milford (Pa.), and Cowdenbeath (Scotland), are given. Ill. 2800 w. Pro Age—Dec. 1, 1898. No. 24346.

Calcium Carbide.

An Account of the First Production of Calcium Carbide and Acetylene in the United States. F. P. Venable. Relates the beginning of the production of this substance at Spray, N. C. 900 w. Am Mfr & Ir Wld—Dec. 16, 1898. No. 24624.

The Calcium Carbide Industry. Report of recent progress dealing with the production, utilization, properties and tests. 3000 w. Engng—Dec. 9, 1898. No. 24641 A.

Dellwik Process.

The Dellwik Water Gas Process. M. Geitel. Translated from the *Polytechnisches Centralblatt*. Brief review of the changes in the history of water-gas. 1400 w. Pro Age—Dec. 1, 1898 No. 24345.

Gas Holder.

The Failure of a Large Gas Holder in New York City. Views of the wreck showing the complete destruction, with explanation of the construction. 800 w. Eng News—Dec. 22, 1898. No. 24681.

Lamp Chimneys.

Chimneys for Incandescent Gas Lamps. Ernest M. White. An account of experiments made with various forms of chimney, with illustrated description of an invention of the writer. 1000 w. Jour Fr Inst—Dec., 1898. No. 24468 D.

Lewes' Method.

Lewes' Method and Apparatus for Manufacturing Gas. Description as given in the patent specification. Ill. 3000 w. Am Gas Lgt Jour—Dec. 26, 1898. No. 24769.

Public Institutions.

Gas v. Electricity for Lighting Public Institutions. Abstract of an article by Carlton Lambert, contributed to *The Hospital*. Gives the relative cost of each at London prices, and generally favors the Welsbach light. 1200 w. Jour Gas Lgt—Dec. 13, 1898. No. 24674 A.

Purification.

Purification. A discussion before the Manchester District Inst. of Gas Engs. 7000 w. Jour Gas Lgt—Nov. 29, 1898. No. 24479 A.

Sheffield, Eng.

Gas Works Extensions at Sheffield. Detailed description of the new station. 3200 w. Gas Wld—Nov. 19, 1898. No. 24315 A.

Sulphur Test.

The Double Sulphur Test for Bisulphide of Carbon. S. Carpenter. Gives a description of this test and the method of its manipulation. 2500 w. Jour Gas Lgt—Nov. 22, 1898. No. 24455 A.

Volumetric Analysis.

The Estimation of Hydrogen, Marsh Gas

and Nitrogen in Mixtures of Gases. E. Jäger. Abstract translation from the *Journal für Gasbeleuchtung.* Describes a fractional combustion method which has given satisfactory results. 2000 w. Jour Gas Lgt—Dec. 13, 1898. No. 24673 A.

Water Gas.

Theory of the Water Gas Process. H. Luggin. Translated from the *Journal für Gasbeleuchtung und Wasserversorgung.* Reviews the theory of Hoitsema, and the results of his experiments brought forward in support of his theory, making application of the theory to the water gas process. 3000 w. Pro Age—Dec. 15, 1898. No. 24625.

SEWERAGE.

Catch-Basins.

Cleaning Catch-Basins, Yonkers, N. Y. Illustrated description of a simple apparatus resulting in a decrease in the cost of cleaning. 500 w. Eng Rec—Dec. 17, 1898. No. 24601.

Sewage.

Bacterial Treatment of Sewage. Editorial discussion of the systems at Exeter and Sutton, Eng., and the views presented by Messrs. Thudicum and Latham. 2000 w. Engng—Dec. 9, 1898. No. 24639 A.

Sewage Works.

The Chorley Sewage Works. Illustrates and describes an intermittent system of purification. 1700 w. Can Engr—Dec., 1898. No. 24551.

Sewers.

The Construction and Ventilation of Sewers. W. Gruggen. Considers the requirements of a properly designed sewer. 2000 w. San Rec—Dec. 16, 1898. No. 24790 A.

STREETS AND PAVEMENTS.

Asphalt.

Theory and Practice of Asphalt Mixtures. A. W. Dow. An explanation of the phenomena met with in asphalt construction, and the importance of selecting the proper sand. 2000 w. Munic Engng—Dec., 1898. No. 24375 C.

Contracts.

The Ethics of Certain Chicago Paving Contracts. Reviews a decision of the Supreme Court of Illinois concerning a contract between an asphalt company and lobbyists employed to promote its interests. 2300 w. Eng Rec—Dec. 17, 1898. No. 24596.

Paving.

A Study of Paving Materials. Edward P. North. Reviews the advantages of different materials. 700 w. Eng Rec—Dec. 3, 1898. No. 24360.

Bituminous Rock Paving in San Francisco, California. Information concerning this material and its use. It is being used to pave Market St., the principal thoroughfare of San Francisco. 1500 w. Eng News—Dec. 22, 1898. No. 24677.

WATER SUPPLY.

Cincinnati, Ohio.

Progress on the New Water-Works for Cincinnati, O. Illustrated description of the comprehensive improvements in progress for which $6,500,000 of bonds have been authorized. 3300 w. Eng News—Dec. 8, 1898. No. 24496.

Filtration.

A New Covered Filter Bed for the Water-Works of Somersworth, N. H. Drawings and description of a slow sand filtration plant covered with a masonry roof. 1600 w. Eng News—Dec. 8, 1898. No. 24498.

The Louisville Experiments with Mechanical Filtration. Gives the leading results of two-years' experiments with different methods of purifying a silt-bearing river water. 2400 w. Eng Rec—Dec. 3, 1898. No. 24358.

Hungary.

The Water Supply System of Faesz. (Die Wasserversorgungs-Anlage der Gemeinde Faesz.) An illustrated account of a small water supply and sewerage plant at Faesz near Veszprem, in Hungary. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 2, 1898. No. 24812 B.

London Supply.

Water Supply from the Chalk. A discussion of the London County Council's Scheme and the opposition to it, and the capability of the chalk as a source of supply. 3500 w. Builder—Dec. 17, 1898. Serial. 1st part. No. 24777 A.

Main Bursting.

The Bursting of a Water-Main in Brooklyn. An account of the great damage caused by the bursting of a 48-inch main. 700 w. Sci Am—Dec. 24, 1898. No. 24703.

Paris.

The Water Supply in Paris. An account of the projects for bringing fresh supplies of water to the city, and the distribution. 2300 w. Engr, Lond—Dec. 16, 1898. No. 24740 A.

Pipe.

Wooden Stave Pipe vs. Riveted Pipe. D. C. Henny. A comparison of the two classes of pipe mentioned, especially setting forth the merits of stave pipe. Discussion. 7600 w. Jour Assn of Engng Soc's—Nov., 1898. No. 24713 C.

Pollution.

The Ashland Water Pollution Case. Review of the decision of the Wisconsin Supreme Court of the liability of a water-company for the quality of water it supplied. 2000 w. Eng Rec—Dec. 24, 1898. No. 24727.

Porto Rico.

The Water-Works of San Juan. William Dinwiddie. A brief description of the works approaching completion which it is hoped will furnish the much needed pure water. 1000 w. Harper's Wk—Dec. 24, 1898. No. 24684.

Purifying.

The Purifying and Sterilizing of Water by Ozone. Translated from *La Vie Scientifique.* Describes the system employed by Mr. Tindal at the municipal works of Saint Maur. Ill. 800 w. Elec, N. Y.—Dec. 28, 1898. No. 24924.

Reservoir.

Construction of a Water-Works Reservoir in Madrid. (Construcción de un Tercer Depósito de Aguas en Madrid.) An illustrated account of the construction of a cellular covered reservoir, 356 by 216 metres in size, in Madrid. It is built of brick and Portland cement and the roof rests on steel beams supported by brick pillars. Its total capacity is 471,520 cubic metres. 2400 w. Revista de Obras Publicas—Nov. 10, 1898. No. 24849 D.

Rochester, N. Y.

Rochester and Its Water-Works. Extracts from the annual report of Chief Engineer Kinchling. 2800 w. Fire & Water—Dec. 17, 1898. No. 24652.

Town Supply.

Town Water-Works from a Financial Standpoint. W. L. Hedenburg. Shows that a town need not necessarily lay out a large sum of money in a pumping plant, nor pay a heavy tax for operating expenses. 2000 w. Munic Engng—Dec., 1898. No. 24374 C.

Tunnel.

The Cleveland Water-Works Tunnel. A progress report on the construction of a tunnel which has already had two fatal gas explosions. 1000 w. Eng Rec—Dec. 17, 1898. No. 24600.

Water Main.

A 61-Inch Cast-Iron Pipe Line. Describes a 61-in. main of pipes 1¼ ins. thick, on which numerous important experiments on the strength of such castings were made. 1700 w. Eng Rec—Dec. 17, 1898. No. 24599.

Water Works.

Improvements of the Water-Works of Council Grove, Kan. L. L. Tribus. Describes improvements to a river supply in an alluvial region, with fairly satisfactory results. Ill. 1500 w. Eng News—Dec. 15, 1898. No. 24587.

Wells.

The Yield of Wells and Collecting Galleries in Permeable Soils. James H. Fuertes. Illustrated article combining the theories of Smreker, Oestern, Lueger, Thêvenet, Kroeber, Soyka, Mancini, Frühling and others in formulas agreeing with experiments. 3200 w. Eng Rec—Dec. 10, 1898. No. 24540.

MISCELLANY.

Boundaries.

State, City and Town Boundaries. Henry B. Wood. Reviews the history of boundaries in Massachusetts and contemplated work in this field. 8000 w. Jour Assn of Engng Soc's—Nov., 1898. No. 24712 C.

Cheap Dwellings.

Cheap Dwellings. (Les Logements à Bon Marché.) A general discussion of the question of cheap and sanitary dwellings for laborers and the poorer classes. 2500 w. La Revue Technique—Nov. 25, 1898. No. 24856 D.

City Charter.

A Model City Charter ; the Report of a Committee of the National Municipal League. Editorial presentation of the main features of the work accomplished by the committee appointed by the National Municipal League to report on a program embodying essential principles of municipal government, &c. 3000 w. Eng News—Dec. 1, 1898. No. 24327.

Refuse Destructors.

Combined Destructor and Electric Light Plants. Ernest Kilburn Scott. Calls attention to some points worth considering before deciding to utilize destructor heat for electric-lighting purposes. 1200 w. Elec Rev, Lond—Dec. 9, 1898. No. 24633 A.

Sanitation.

Theatre Sanitation. William Paul Gerhard. Read at meeting of the Am. Pub. Health Assn., at Ottawa, Can. A paper on the hygiene of theatres, considering drainage, plumbing, water supply, ventilation and general sanitation. 5500 w. San—Dec., 1898. No. 24417 D.

The Relative Importance of Flies and Water Supply in Spreading Disease. Dr. M. A. Veeder. Abstract of paper read at meeting of the Buffalo Sanitary Club. A discussion of dangers from these sources, and means of prevention. 2500 w. Eng News—Dec. 22, 1898. No. 24676.

The Scientific Prevention of Yellow Fever. Alvah H. Doty. Considers the cause of this disease, the manner in which it is propagated, the means of overcoming the conditions, &c., with remarks on the need of a national health bureau. 6800 w. N Am Rev—Dec., 1898. No. 24386 D.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in October. Detailed list with classified summary and remarks. 3500 w. R R Gaz—Dec. 2, 1898. No. 24405.

Character.

Conduct and Character. M. N. Forney. A lecture to railroad and supply men on this subject. 14800 w. N Y R R Club—Nov. 17, 1898. No. 24579.

Cost of Hauling.

The Comparative Costs of Highway Haulage. (Sue Confronto Economico dei Tracciati Stradali.) D. Ruggeri. A rather elaborate study of methods of comparing costs of haulage on different roads and of calculating approximate costs for moving freights on highways in contemplation, with the bearing of these costs on the design of such roads. Serial. 1st part. 5000 w. Annali d Soc d Ing e d Archit Ital—Sept-Oct., 1898. No. 24872 E.

Russian Railroads.

Russian Fares and Trains and the Siberian Railroad. Information of interest concerning the transportation system, and probable cost, at present rates, of a journey from London to China. 2000 w. R R Gaz—Dec. 23, 1898. No. 24720.

Snow.

The November Snow Storm on Long Island. An illustrated account of the struggle against the recent heavy snow on the railroads, especially on Long Island. 600 w. R R Gaz—Dec. 16, 1898. No. 24591.

Weak Bridges.

Is it Safer to Run Fast or Slow Over a Weak Bridge? A communication from an engineer advocating running fast and giving reasons. 1400 w. Eng News—Dec. 8, 1898. No. 24497.

FINANCIAL.

Railway Incomes.

Railways and Prosperity. Extract from the report on the railways of Pennsylvania for the year ending June 30, 1898, prepared by Isaac B. Brown, superintendent of the Bureau of Railways. 3600 w. Ry Age—Dec. 16, 1898. No. 24667.

Supplies.

The Purchase and Inspection of Railway Supplies. Editorial discussion of paper by H. B. Hodges, read at the Oct. meeting of the N. Y. R. R. Club. 800 w. Ry Mas Mech—Dec., 1898. No. 24394.

LEGAL MATTERS.

Anti-Scalper Law.

New York Anti-Scalper Law Dead. The opinion rendered by the New York Court of Appeals, with editorial. 4500 w. R R Gaz—Dec. 2, 1898. No. 24404.

Anti-Trust Act.

The Scope and Effect of the Anti-Trust Act. From the *Yale Review*. A brief review of railroad history in this connection and a discussion of the legislation on this subject in the United States, as compared with England. 1200 w. R R Gaz—Dec. 9, 1898. No. 24488.

Cotton Tariff.

The Decision in the Texas Commission Cases. Decision rendered by Judge A. P. McCormick. A complete victory for the railroads. 2800 w. Ry Age—Dec 9, 1898. No. 24546.

Interstate Commerce.

The Powers of the Interstate Commerce Commission. Basil W. Duke. A discussion of the views advanced by Charles A. Prouty, in the November number of the *N. Am. Review*. 4300 w. R R Gaz—Dec. 16, 1898. Serial. 1st part. No. 24593.

MOTIVE POWER AND EQUIPMENT.

Bolsters.

The Computation of the Deflection of Body and Truck Bolsters. William Kendrick Hatt. Derives a formula for the case of uniform loading and for end loading. Also gives a description of a graphical process for drawing the curve into which the bolster will bend under any loading, from which curve the deflection at any point may be obtained. 2000 w. R R Gaz—Dec. 23, 1898. No. 24717.

Car Locks.

Continuous Safety Lock System for Railway Cars. (Chiusura Continua di Sicurezza per i Veicoli Ferroviari.) G. Kaiser. Describes a method for locking all the doors of a train of compartment cars by a compressed air system operated from the locomotive or from each car and automatically unlocking in case of accident. 1000 w. 1 plate. Annali d Soc d Ing e d Archit Ital—Sept.-Oct., 1898. No. 24873 E.

Cylinders.

Locomotive Cylinder Proportions. G. R. Henderson. A discussion of this subject, giving the opinion that the weight on drivers should be proportioned to maximum rates of grades, while the steam-making capacity should be proportioned to the average resistance and schedule speed. 3200 w. Am Eng & R R Jour—Dec., 1898. No. 24379 C.

Dump Car.

A Sectional Dump Car. Illustrates and describes the Page car, which consists of a series of dumping boxes mounted on the car frame. 1000 w. Eng News—Dec. 22, 1898. No. 24678.

Framing.

The Framing of Cars. F. M. Whyte. Extract from paper read before the Western Railway Club, with editorial comment. Suggestions for improvements in the distribution of loads. 3000 w. Ry & Engng Rev—Dec. 24, 1898. No. 24774.

Locomotives.

Compound Freight Locomotives for the Paris-Lyons-Mediterranean Rwy. (Locomotives Compound à Marchandises de la Cie. P.-L.-M.) Description of a four-coupled compound, illustrated by elevations. The high pressure cylinders are outside, while the low-pressure cylinders are mounted close together inside the frame and operate cranks on the second axle. 1200 w. Le Génie Civil—Nov. 19, 1898. No. 24863 D.

Mogul Locomotives for the Delaware, Lackawanna & Western. General specifications with illustration. 200 w. R R Gaz—Dec. 2, 1898. No. 24406.

Narrow-Gauge Locomotive for the Cauca Railway. Illustrated description of an engine for a South American road, built at the Baldwin Locomotive Works. 1000 w. Am Eng & R R Jour—Dec., 1898. No. 24381 C.

New Express Engines on the Great Eastern Railway. Charles Rous-Marten. Records results attained during several experimental journeys with these engines. 1800 w. Engr, Lond—Dec. 2, 1898. No. 24528 A.

High Speed Locomotive. (Note sur une Locomotive à grande Vitesse.) Ch. Corteil. This locomotive was built to haul 250 ton trains on level roads at a speed of 50 miles per hour. Its principal peculiarity was in the use of a fire box of refractory bricks. 1800 w. 1 plate. Rev

Univ des Mines—Nov. 1898. No. 24877.

Recent Brooks Locomotives—B. R. & G. Ry. and O. R. & N. Co. Illustrated description and interesting comparison of freight engines built for a far western road with those built for an eastern road. 1200 w. Ry & Engng Rev—Dec. 10, 1898. No. 24566.

Some Recent Rogers Locomotives. Principal specifications, with illustration, of 10 wheel freight locomotives for the Illinois Central R. R. 500 w. R R Gaz—Dec. 2, 1898. No. 24403.

The Evolution of the Locomotive Engine. William P. Marshall. From a paper read before the Inst. of Civ. Engs., London. A record of the leading steps in the evolution of the present locomotive, with notice of further steps now in process of trial. 2300 w. R R Gaz—Dec. 2, 1898. No. 24402.

The Present Status of the Compound Locomotive. Reviews the opinions of railroad officers with regard to the value of this type, showing the wide differences and concluding that with light loads there is nothing to be gained by compounding. 1400 w. Am Eng & R R Jour—Dec., 1898. No. 24382 C.

Private Train.

The Private Train of the Emperor of Germany. Illustrated detailed description. 2500 w. R R Car Jour—Dec., 1898. No. 24509.

Smoke.

Burning Soft Coal without Smoke. Angus Sinclair. Describes the practice on the Burlington, Cedar Rapids & Northern Railway which secured smokeless locomotive firing, and greatly lessened the fuel expense. Ill. 5000 w. Loc Engng—Dec., 1898. No. 24397 C.

Smoke Boxes.

Short Smoke Boxes for Locomotives. Discussion of the present tendency in design, stating the advantages of short fronts, and describing the arrangements devised by different makers. Ill. 2200 w. Am Eng & R R Jour—Dec., 1898. No. 24380 C.

NEW PROJECTS.

China.

Foreign Possessions in China, and their Prospective Railways (Die Fremden Besitzungen in China und deren Künftigen Eisenbahnen.) H. Post. A discussion by the Austrian consular attaché at Shanghai, of the probable development of Chinese railways consequent upon political changes. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 18, 1898. No. 24811 B.

Indian Railway.

Nilgiri Railway. Part first discusses gradients and curves, stations, tunnels, ballast, brakes, &c. 2000 w. Ind Engng—Nov. 12, 1898. Serial. 1st part. No. 24636 D.

Madagascar.

Railway Contract in Madagascar. A copy of a concession for a railway from Tananarivo to Tamatave. 2800 w. U. S. Cons Repts—Dec., 1898. No. 24519 D.

Railway Extensions.

City and South London Railway Extensions. Illustrates and describes the interesting operations in connection with this work. 1400 w. Elec Rev, Lond—Dec. 16, 1898. No. 24784 A.

Siberia.

See Economics and Industry, Commerce and Trade.

Trans-Saharan Railway.

The Trans-Saharan Railway (Le Chemin de Fer Transsaharien.) Account of a proposed railway across the Sahara desert which will be of great strategic value to the French colonies in Africa. It is proposed to prolong the Sfax-Gafsa line across the desert to Lake Tchad, about 2000 kilometers. 1200 w. Moniteur Industriel—Oct. 15, 1898. No. 24888 E.

PERMANENT WAY, BUILDING AND FIXTURES.

Block System.

The Block System on the Atchison. Details of the regulations under which trains are run, with facts of interest concerning the apparatus. Ill. 1200 w. R R Gaz—Dec. 23, 1898. No. 24718.

Concrete Structures.

Concrete Railway Structures. F. G. Jonah. Read before the Canadian Soc. of Civ. Engs.—Dec. 8, 1898. Illustrates and describes designs of concrete culverts and bridge piers. 800 w. Adv Proof. No. 24582.

Interlocking.

Interlocking at Greensburg, Ind. Illustrated description of a plant especially interesting because of the arrangement of the levers. 1200 w. R R Gaz—Dec. 9, 1898. No. 24485.

Joints.

The Construction of Rail Joints. (Ueber Stossfugen-Ueberbruckung.) A paper by Dr. Vietor before the German Railway Society, discussing the action of shock upon rail joints, and the best methods of diminishing injurious action. 4000 w. Glaser's Annalen—Dec. 1, 1898. No. 24819 D.

Kobe Workshops.

The Workshops of the Japanese Imperial Railways at Kobe. Notes relating to these shops, with general remarks. 1200 w. Engr, Lond—Nov. 25, 1898. No. 24433 A.

Midland Railway.

The Midland Railway in London. Illustrated description of the Kentish Town widening and Somers Town coal depot, reconstruction of stations, &c. 2800 w. Transport—Nov. 18, 1898. No. 24314 A.

Railway Extension.

Great Northern and Strand Railway. Describes the extension of this system into the center of London. Map. 1400 w. Transport—Nov. 25, 1898. No. 24449 A.

Safety.

The Evolution of Safety in Railway Travel. Charles Hansel. This interesting paper traces the development of safety appliances for railways from the beginning. It treats of methods of switching and signalling, interlocking devices, the protection of road grade-crossings and the crossings of steam and electric railways. The mechanism of signal cabins is fully described and illustrated, other illustrations also showing signals protecting stations and drawbridges. 4100 w. Engineering Magazine—Jan., 1899. No. 24897 B.

Sleepers.

The Hasselmann Process for Treating Railway Sleepers. (Ueber die Tränkung der Eisenbahnschwellen nach Hasselmanns Verfahren.) The process consists in forcing into the pores of the wood a solution consisting of a mixture of sulphate of alumina and sulphate of iron and copper. 1800 w. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1898. No. 24816 D.

Station.

New Passenger Station at Albany, N. Y. Brief description with illustrations of the plans decided upon for a station to accommodate the N. Y. C. & H. R. R. R., the B. & A., and the D. & H. railroads. 400 w. R R Gaz—Dec. 16, 1898. No. 24592.

Steel Rail.

Life of Steel Rails in Italy. Observations on the wear of steel rails on the various lines of the Adriatic Railway of Italy. 900 w. Ry & Engng Rev—Dec. 10, 1898. No. 24568.

Terminal.

The New Terminal Station of the Orleans Rwy. Co. (La Nouvelle Gare Terminus de la Compagnie d'Orleans.) Alfred Boudon. An illustrated description of the condition of the work at the Quai d'Orsay (Paris) with numerous plans of buildings, etc. 3500 w. Le Génie Civil—Nov. 19, 1898. No. 24861 D.

Track Tanks.

The Use of Track Tanks. Editorial on the limited use and the reasons why they are not usually profitable. 1300 w. R R Gaz—Dec. 9, 1898. No. 24489.

Water Station.

Submerged Water Station N. P. Ry. Illustrates and describes a system of water supply, invented by E. H. McHenry, in which a submerged tank is used for storage, and steam from the locomotive used to force the water into the tender tank. 800 w. Ry & Engng Rev—Dec. 17, 1898. No. 24659.

TRAFFIC.

Express Charges.

An Attack upon Railways Through the Express Companies. Editorial discussion of the schedule of charges prepared by the Merchants' Association of New York, and the statements made. 1400 w. Ry & Engng Rev—Dec. 24, 1898. No. 24775.

Pooling.

The Decision Against Railway Pooling. Roswell Miller. Thinks the only remedy for the existing state of things, is to permit agreements among roads as to rates, and to permit pooling. 1000 w. N Am Rev—Dec., 1898. No. 24-388 D.

STREET AND ELECTRIC TRAMWAYS.

Accounts.

Theory of Reserve and Suspense Accounts. A. O. Kittredge. A discussion showing the necessity of these accounts and illustrating by example. Also considers the objections usually urged. 2500 w. St Ry Jour—Dec., 1898. No. 24413 D.

American Traction.

A French View of American Electric Traction. Extracts from French journals taken from notes of French engineers sent to study American methods. 1300 w. Elec Rev, Lond—Nov. 25, 1898. No. 24443 A.

Braking.

The Braking Action of Induction Motors (Ueber die Bremsung von Induktions Motoren.) Friedrich Eichberg. A mathematical discussion of the various methods by which the braking action of induction motors may be effected with especial reference to use for tramway service. 5000 w. Elektrotech Zeitschr—Nov. 24, 1898. No. 24837 B.

Capital Traction Co.

The Open-Conduit System of the Capital Traction Company. Illustrates and describes the reconstruction of the tracks, the power-house, coal-conveying apparatus, boilers, flues and stack, steam and water piping, engine room, &c., with editorial. 6500 w. Elec Wld—Dec. 31, 1898. No. 24920.

Conduit Construction.

Conduit Construction of the Third Avenue Railway Company, New York. The work of changing from the cable to the electric system is described; also the horse lines that are to be equipped electrically, and other improvements in rolling stock, &c., to be made by this line. 2500 w. St Ry Jour—Dec , 1898. No. 24412 D.

The New Bastille-Charenton Line of Electric Tramways. (La Nouvelle Ligne de Tramways Electrique Bastille-Charenton.) J. Prouteau. A well illustrated description of this line, the first overhead trolley railway in Paris, with special reference to the construction of the conduit section. 4000 w. La Revue Technique—Nov. 25, 1898. No. 24856 D.

Construction Work.

Roadbed Over a Sewer. Illustrates and briefly describes a piece of ingenious work found necessary in laying the electric conduit in Canal St., New York. 350 w. St Ry Rev—Dec. 15, 1898. No. 24723 C.

Egypt.

Electric St. Railroads in Cairo, Egypt. Brief illustrated description of the rapid-transit system inaugurated August, 1896. 700 w. Elec Wld —Dec. 31, 1898. No. 24921.

Electric Railroads.

The Coming Electric Railroad. Sidney H. Short. A discussion of the chief points in effecting a change from steam to electricity on trunk lines. Ill. 4000 w. Cos—Jan., 1899. No. 24662.

Electric Traction.

Conduit v. Trolley. A brief description of the excellent design of center poles and other equipment used on the Bastille-Charenton Line, Paris, with comparison of the first cost in conduit and trolley lines. 1200 w. Elec Rev, Lond—Dec. 9, 1898. No. 24631 A.

Electrolysis.

Some Fallacies Regarding Electrolysis. Albert B. Herrick. Considers the conditions necessary for its existence in railway systems, methods of locating the paths of destructive currents, the methods of prevention, &c. Ill. 4400 w. St Ry Jour—Dec., 1898. No. 24411 D.

Elevated Railroad.

Chicago Metropolitan West Side Elevated Electric Railroad. Briefly describes the plan of the lines, the power-house and its equipment, track construction, &c., giving illustrations. 1500 w. Elect'n, Lond—Nov. 18, 1898. No. 24318 A.

Some Elevated Railway Problems and Results. Considers the conditions confronting the "station class" of railways, especially discussing the elevated systems in New York and Chicago. Ill. 4500 w. St Ry Jour—Dec., 1898. No. 24407 D.

The Multiple Unit System on the South Side Elevated Railway of Chicago. Discusses the Sprague system, its interesting features and appliances, stating its advantages. Ill. 2800 w. St Ry Jour—Dec., 1898. No. 24408 D.

The Union Elevated Railway of Chicago. Illustrated description of the "Loop" property in Chicago, and its working. 2000 w. St Ry Jour—Dec., 1898. No. 24409 D.

Interurban.

The Interurban Railway Between Anderson and Marion, Ind. Illustrates and describes the road and its equipment. 1200 w. St Ry Jour—Dec., 1898. No. 24410 D.

Mileage.

Railway Mileage in Foreign and American Cities. From the *Surveyor*, of London. Gives figures upon the cost of operating trolley lines, and table giving the miles of track and population per mile. 800 w. St Ry Rev—Dec. 15, 1898. No. 24722 C.

Paris Metropolitan.

The Metropolitan (Railway) in Paris. (Le Métropolitain de Paris.) Georges Leugny. An illustrated description, with map, of this important undertaking, giving also historical data, particulars of tunnels, stations, costs, methods of work, etc. 4000 w. La Revue Technique—Dec. 10, 1898. No. 24854 D.

Power Station.

The Harvard Power Station of the Boston Elevated Railway Company. H. W. Weller. Brief review of street-railway history in Boston, with illustrated detailed description of the Harvard Power Station and its equipment. 3500 w. Ry Wld—Dec. 8, 1898. No. 24900 A.

Union Elevated Railroad Power House, Chicago. Illustrated detailed description of this recently completed station. 1800 w. Elec Eng, N. Y.—Dec. 15, 1898. No. 24571.

Street Railways.

Practical Points in Street Railway Engineering. W. A. Harding. Read before the Chicago Elec. Assn. Some points on the selection of cars, motors, etc., for suburban roads. 1200 w. Elec Rev, N. Y.—Dec. 14, 1898. No. 24564.

Surface Contact.

Surface Contact Electric Railways. Edward H. Johnson. Read before the New York Elec. Soc. Discusses the causes that have retarded the development of this idea, and notes briefly the salient features of the most ambitious efforts in this field. Ill. 4700 w. Elec, N. Y.—Nov. 30, 1898. No. 24305.

Thompson-Walker System.

The Thompson-Walker System of Electric Traction. A brief illustrated sketch of this system taken from a pamphlet published by the inventors. 1100 w. Elec, Lond—Dec. 9, 1898. No. 24626 A.

Ties.

The Preservation of Ties. W. H. Glenn. Recommends treating the ties with creosote, and gives suggestions relating to the plant. 1800 w. St Ry Rev—Dec. 15, 1898. No. 24724 C.

Tramways.

Conduit vs. the Trolley System. Report of Mr. John Young to the Glasgow Tramways Committee on the advisability of introducing the conduit system. 3500 w. Ry Wld—Dec. 8, 1898. No. 24904 A.

Liverpool Corporation Electric Tramways. An illustrated description of the portion of the line opened for traffic. 2500 w. Elec Rev, Lond—Nov. 18, 1898. No. 24316 A.

Street Railways of Meadville, Pa. Information relating to the electric lines of this city and the traffic. Ill. 1000 w. St Ry Rev—Dec. 15, 1898. No. 24721 C.

The Lausanne Electric Tramways. C. Du Riche Preller. Illustrates and describes a system especially interesting because of its exceptionally steep grades. 5000 w. Engng—Dec. 16, 1898. No. 24744 A.

The Tramways of Blackpool and Neighborhood. Notes taken on a recent visit on the working of the three systems operated in this vicinity. 2000 w. Ry Wld—Dec. 8, 1898. No. 24902 A.

Vienna Tramways. An account of provisions for a comprehensive system of electric traction. 1400 w. Ry Wld—Dec. 8, 1898. No. 24903 A.

Trucks.

A Test of the Peckham Truck. This company having the contract to furnish trucks for the South Side Elevated in Chicago, a special test to demonstrate the strength was made, and is described. Ill. 700 w. R R Gaz—Nov. 25, 1898. No. 24210.

Vienna.

Electric Traction in Vienna. Brief description of combined trolley and accumulator lines, with engravings of rail and car. 900 w. Ry Wld—Nov. 10, 1898. No. 24045 A.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Buffalo Forge Company, Buffalo, N. Y., U. S. A.=Handsomely illustrated catalogue (*a*) describing the forge shops in a number of American schools of mechanical technology in which Buffalo forge equipments are used; (*b*) showing various forms of Buffalo automatic steam engines.

Jeffrey Mfg., Co., Columbus, Ohio, U. S. A.= Catalogues (*a*) of chain belting and steel cable elevating and conveying machinery; (*b*) special price list of elevator buckets and spiral conveyors; (*c*) Jeffrey electric locomotives for mine haulage.

Cincinnati Milling Machine Company, Cincinnati, Ohio, U. S. A.=Illustrated catalogue of improved universal cutter and tool grinder, with photographic reproductions showing the great variety of work of which the machine is capable.

Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., U. S. A.=Illustrated catalogue descriptive of the modern round house turntable, showing the Westinghouse turntable "donkey" as applied to existing turntables.

Westinghouse, Church, Kerr & Co., New York.=Small, well printed pamphlet giving a bird's eye view of the general business of the firm, with numerous illustrations of Westinghouse steam and gas engines.

General Electric Company, Schenectady, N.Y., U.S.A.=Handsomely printed catalogues (*a*) describing and illustrating Thomson recording watt meters for various kinds of service, with diagrams showing connections, together with useful information regarding electric meters; (*b*) catalogue describing transformer design and operation, including papers by W. J. White and W. E. Goldsborough.

Lidgerwood Mfg. Co., New York.=Publications as follows: (*a*) general catalogue of hoisting engines, cableways, log hauling machinery, hoisting and conveying apparatus, and Tremperley transporters; (*b*) illustrated catalogue of devices for logging by steam; (*c*) advance proofs of Lidgerwood safety derrick engine; (*d*) pamphlet showing contractor's methods employed on the Chicago drainage canal; (*e*) catalogue of the Lidgerwood rapid unloader; (*f*) catalogue of the Tremperley transporter and Lidgerwood transfer.

Baldwin Locomotive Works, Philadelphia, Pa., U.S.A.=Record of recent construction for December, 1898, giving illustrations and specifications of simple and compound locomotives built for various railways in the United States, Mexico, New Zealand, Finland, and China.

Chester B. Albree, Allegheny, Pa., U. S. A.= Catalogue of ornamental and structural iron work, bridge railings, stairways, portals, etc., also pneumatic riveting machines.

Lombard Water-Wheel Governor Company, Boston, Mass., U. S. A.=Catalogue B, descriptive of various forms of water-wheel governors, with instructions as to data for estimating, and testimonials from users.

Hilles & Jones Company, Wilmington, Del., U. S. A.=Catalogue P, of machine tools for working plates, sheets, bars, and structural shapes, with many illustrations of powerful machines for punching, shearing, bending, and riveting, arranged to be driven by belting, steam, or electric power.

E. W. Bliss Company, Brooklyn, New York, U. S. A.=Handsome album of views of various interiors in the establishment of the E. W. Bliss Company, showing the extent of the works and character of the equipment.

Rumsey & Co., Limited, Seneca Falls, N. Y., U. S. A.=Pamphlet catalogue of triplex power pumps, adapted for a variety of heads and pressures, and arranged to be driven by belt or electric motor.

The American Fireproofing Co., Boston, Mass., U. S. A.=Catalogue describing Merrill's Salamander fire-proof composition for buildings, with examples of its application, and testimonials from users.

The Deane Steam Pump Company, Holyoke, Mass., U. S. A.=General catalogue of Deane steam and power pumps and pumping machinery for every variety of service. Details of dimensions, speeds, capacities and pipe sizes are given, with telegraph code words, and numerous tables of useful information.

Denver Engineering Works, Denver, Colorado, U. S. A.=Catalogue of steam and electric hoisting plants especially adapted for mining service, also hoisting rope of steel wire, and general accessories for mine hoisting plants.

The Bedford Engineering Co., Bedford, England.=Price-list of steam cranes. Illustrated.

Lake & Elliot, Albion Works, Braintree, England.=Illustrated price-list of tools for cycle makers and repairers.

Robert Boby, Ltd., Bury St. Edmunds, England.=(*a*) Catalogue of grain, malt, and seed cleaning machinery. Fully coded, illustrated, and priced. (*b*) Condensed price-list of above machinery.

Chas. Taylor, Bartholomew street, Birmingham, England.=Illustrated catalogue of lathes and tools for grinding; also of milling machines, vices, and engineer's hand tools. Good descriptions, prices being given in each case.

Graham & Fleming, Premier Works, Halifax, England.=Catalogue of wrought-iron and steel, welded and riveted boilers for domestic use; also of valves, cisterns, furnace fronts and copper boilers. Sectional illustrations and tables of sizes, prices, and heating powers expressed in terms of 4 inch pipe are given in each case. Stiff cover.

E. & J. Richardson, Elswick Leather Works, Newcastle-on-Tyne, England.=Price list of leather belting, with useful tables of horse power transmitted by various sizes. Folder style.

Holden & Brooke, Ltd., Manchester, England.=8 page catalogue of Brooke's "Anti-primer" steam dryer and purifier with description, prices, and drawings; showing application to various types of engines.

W. E. Kenway, Burlington Chambers, New St., Birmingham, England.=Pamphlet describing Kenway's electric traction system with illustrations; also brief account of the "Victor" rail joint.

Thomas Summerson & Sons, Darlington, England.=Handsome cloth volume entitled "A Handy Platelayer's Guide," containing useful tables and diagrams of switches and crossings. The book covers 90 pages, of which the first thirty are devoted to general information on permanent way, the remainder to tables and diagrams.

E. D. Reeve, 60 High street, Wandsworth, London.=Catalogue of laundry machinery giving wood cut views of various types of machines and information about Reeve's combined washing machine, hydro-extractor, and tumbler. Paper cover.

Woods & Co., Suffolk Iron Works, Stowmarket, England.=Illustrated price lists; (*a*) of grinding mills, malt crushers, oil cake breakers, shedders, etc. 28 pages of condensed information; (*b*) of field implements such as rolls, harrows, sheep hurdles, water carts, etc. An illustration of each machine is given. Paper cover.

Darlington & Co., Llangollen, Wales.=Preliminary circular relative to Darlington's handbooks.

Blackstone and Co., Ltd., Stamford, England.= (*a*) Price list of hay harvesting machines, including rakes and mowing machines, with full description of each type; (*b*) Circular giving sizes, prices and testimonials of the Blackstone oil engine.

Mackies, Ltd., Berks Iron Works, Reading, England.=Illustrated catalogue of pulleys, gearing, pedestals, and general millwright work; also of wrought iron gates, and wheelbarrows. Stiff paper cover.

W. & T. Avery, Ltd., Soho Foundry, Birmingham, England.=Illustrated catalogue of weighing apparatus, in three sections, dealing respectively with weighbridges, platform weighing machines, and miscellaneous machines, such as wire testers, hot rail weighers, etc.

C. J. Edwards & Son, Ltd., 32 Great Sutton street, London, E. C.=Illustrated price-lists (*a*) of shafting plummer blocks, cast iron and wood pulleys hangers, and other shafting appliances; (*b*) of leather belting and engineers' sundries, such as oil cans, lubricators, belt-fasteners, etc.

E. S. Hindley, Bourton, Dorset, England.= Price-list of vertical and horizontal steam engines and boilers, saw benches and pumps, with weights, measurements, powers, and quantities. Fully illustrated. 48 pp.

Bickford Smith & Co., Ltd., Tucking Mill, Cornwall, England.=Descriptive and illustrated price list of safety and instantaneous fuses for blasting Twenty-seven types of fuses are enumerated; the catalogue contains many useful facts about blasting. Cloth cover. 67 pp.

D. H. Bonneller & Son, 58 Mortimer street, London, W.=Illustrated price-lists (*a*) of electric bells and accessories; (*b*) of incandescent lamps.

Spencer & Co., Ltd., Melksham, Wilts, England.=Hand-book of illustrations from photographs of work carried out for mechanical handling of grain, seed, coal, etc., with brief descriptions.

W. H. Willcox & Co., 34 Southwark street, London, S. E.=Price-list of a great variety of oils, engineers' hand tools, valves, gauges, pulleys, and mill and railway furnishings. Complete index. 191 pp.

F. Barker & Son, 12 Clerkenwell road, London, England.=Trade catalogue of pocket and ship compasses, barometers, and a variety of scientific and surveying instruments. Prices invariably given. 100 pp.

Woodite and Whaleite Works, Mitcham Common, Surrey, England.=Price-list of woodite and whaleite goods as used for packing, mats, shoe soles, corks, washers, hose, etc.

The Reeves Patent Filters Co., Ltd., 39 Victoria street, Westminster, London, E. C.=Circulars illustrating, describing, and giving list of users of (*a*) The Reeves patent feed-water filter; (*b*) the Destrumaux automatic water softeners; (*c*) The Reeves gravity filter.

Bryan Donkin & Co., Ltd., Southwark Park road, Bermondsey, London.=(*a*) Catalogue of exhausting plant for gas-making, with list of users; also of hydraulic regulators, fully illustrated. Detailed descriptions; (*b*) price-list of valves for gas, chemical, and other uses; (*c*) six circulars dealing with Fleron & Andersen's stop valve, steam engines, blast fans, air propellers, oil engines, and exhaust steam valves.

W. T. Glover & Co., Ltd., 39 Victoria street, London, S. W.=Catalogue of electric light wire and cable, with finger index, containing dimensions, capacity, resistance, weight, and other particulars.

Thos. Barraclough, 20 Bucklersbury, London, E. C.=Illustrated price-lists: (*a*) Wire strand and wire rope machinery; (*b*) hemp rope machinery. Both lists are well illustrated, and contain considerable technical information.

Clayton, Howlett & Co., Atlas Works, Woodfield road, Harrow road, London.=Illustrated catalogue of brick-making machinery, plastic and semi-dry, presses, tile and pipe machinery; also listing portable railways, grinding mills, and engines. 54 pp. Paper cover.

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READINGS FROM EXPERIENCE IN NAVAL ENGINEERING.

By Engineer-in-Chief George W. Melville, U. S. N.

A VERY important problem in the high-powered machinery of modern war vessels is the combination of economy at cruising speeds with power at the maximum speed. The size of the engine is necessarily fixed by the maximum power, yet this power in times of peace is used only on the rare occasions of full-power trials. Ordinary cruising takes place at about half the maximum speed, which corresponds to something less than one-eighth of the maximum power. If the machinery is designed for fair economy at maximum power, it will be enormously too large for the cruising power, and this leads to a marked reduction in economy.

Those who have not carefully investigated the subject are surprised to find that, while merchant steamers secure a horse power, with modern triple-expansion engines, for something less than two pounds of coal per i. h. p., it frequently happens that war vessels of the same size, at the same speed, use considerably more than two pounds of coal, and sometimes more than three. The cause of this difference is that in the merchant vessel the engine works under its best conditions all the time, while in the war vessel it is probably working under the least economical conditions. To obviate this, various methods have been proposed. One is that mentioned as obtaining on the New York and the Brooklyn, where there are two engines on each shaft, with a coupling between, so that at cruising speeds the forward engines can be disconnected and only the after ones used. Another is the use of triple screws, as on the Columbia and Minneapolis. Still another is the arrangement on the Nashville, where the engine works as a quadruple-expansion engine at full

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power, with arrangements for disconnecting the low-pressure cylinder and running the other three as a triple-expansion engine under ordinary cruising conditions. None of these is entirely satisfactory from all points of view, and each has some good features. As stated in the previous paper, the objection to any scheme which involves disconnecting part of the power on one shaft is that, in cruising under the economical conditions, should a sudden demand arise for full power, it may happen that time cannot be taken for making the connection. The triple screws avoid this tactical objection, and it seems probable that, as time goes on, their use will largely increase.

Another subject of great importance, with respect to economy, is that of the steam-consumption of the auxiliary machinery. In the early naval vessels of the United States navy there were very few independent auxiliaries, all the pumps for use during cruising being run from the main engine, which, of course, insured at least the economy due to that engine. But, as the rotational speeds have increased, it has been found desirable to require of the main engine only the work of driving the propeller, and this has led to the multiplication of auxiliaries, until some large naval vessels now have more than a hundred steam cylinders, besides those of the main engines. For simplicity and reliability most of these auxiliaries are driven by simple engines working without expansion and without jacketing, so that, as regards economy, they work under the most unfavorable conditions possible.

In a paper read last year by Passed Assistant Engineer White, of the United States navy, an account was given of experiments with the auxiliary machinery of the Minneapolis, which gave results that are undoubtedly true of any ship; in nearly every case the steam-consumption was very high, in some cases amounting to more than two hundred pounds of steam per i. h. p. per hour. Of course, in the case of these phenomenally high rates, the horse powers are extremely small; and it must also be remembered in this connection that, during ordinary cruising, only a small number of the auxiliaries are in use at the same time. But the fact remains that they are very wasteful, and that there is here a field for progress.

Numerous methods of increasing the economy have been proposed, some of which are thoroughly practical, and some, while very promising, are barred by the limitations of war-vessel design. All machinery on United States naval vessels is now arranged so that the exhaust from the auxiliaries may be turned into one of the receivers; where this has been done, a considerable saving in coal has resulted, amounting, in some of the larger ships, when running at a fair rate of speed, to several tons per day. An extension of this principle has been proposed, where the cylinders of the auxiliaries would, in effect, form a part of the intermediate cylinder, as they would take steam from the first receiver and exhaust into the second. To this, however, there is the objection that, as war vessels are liable to be called upon at times to work with numerous stoppages, provision would have to be made, in addition, to take the steam direct from the boilers and exhaust into the condenser. Another scheme in use on the vessels now building is that of having the exhaust from the auxiliaries go through a feed-water heater, thereby saving a large amount of the heat which would otherwise be wasted when the steam is condensed in the main condenser. As it is very important that the feed water, before entering the boiler, should be as hot as possible, this method is advantageous from two points of view.

It has also been proposed to drive most of the auxiliaries (indeed, all of them) by electricity, and this has been done to some extent in the substitution of electric motors for steam engines or hydraulic motors for turning the turrets, and in the use of electric motors for hoists. Where the auxiliaries to be driven are far from the boilers, or where there would be great complication in pipe connection, the electric motors certainly offer points of advantage in facility of installation; unfortunately, there are disadvantages connected with their use, which count for a great deal where weight is so undesirable as it is on board ship. To be light, motors must run at a very high speed, and for most purposes on board ship this involves the introduction of gearing, which adds to the weight, and also is objectionable on the score of noise. Another very important feature is the fact that, thus far at least, the engines usually installed for driving the electric generators are not, in the long run, of very much greater economy than the small auxiliary steam engines which it is proposed to supersede by the electric motors; and, although the efficiency of both generators and motors is very high under the best conditions, these efficiencies fall off when worked at powers much below the normal. When the prime mover is itself not specially economical, the resulting economy may be even less than that achieved by the direct use of steam, while the weight in such a case is enormously greater. Before electricity can be used economically for driving the detached machinery, it is of first importance that the engine used to drive the generator not only shall be economical when new and subjected to test, but shall maintain the economy for a long time.

We have already observed that speed is a most important factor in all war vessels, and there is as yet no limit to this factor of the efficiency of the fighting ship. Not very long since, a speed of 16 knots was considered satisfactory for the heavily-armored battleships, but contracts have just been placed for three vessels of this class in the United States, which are to have a top speed of 18 knots, and in the next ones to be laid down this speed will probably be at least 18½. There are a few battle-ships which exceed this figure, and the Italians are laying down three which are to have a speed of 21 knots, but these vessels will undoubtedly belong rather to the armored-cruiser class. Of the vessels in this latter class, several are now building which are to have a speed of 23 knots, the one nearest completion being the Jeanne d'Arc of the French navy, while the new Powerfuls about to be laid down for the British navy will combine with this high speed almost the offensive and defensive qualities of a battle-ship. The armored cruisers which the United States are likely to build, if congress grants the money at the approaching session, will probably not have quite so high a speed as this, as they will be some three thousand tons smaller. In the class of protected cruisers high speeds are also the rule, and the French expect soon to have two triple-screw flyers—the Guichen and the Châteaurenault—very much like the American triple-screw vessels, and of about the same size and speed.

A word may be said about the torpedo vessels, now divided into the destroyers and torpedo boats, although from the engineering standpoint they are practically identical except as to power. In these little vessels everything has been sacrificed to high speed, not only in the hull scantlings, but in those of the machinery itself, and wonderful results have been produced by the skilful utilization of the splendid material now available. In the war between the United States and Spain the torpedo vessels played a very minor part, and, indeed, may almost be said to have proved failures, as the American boats made no attacks and the Spanish boats were overwhelmingly defeated. I have never been a great believer in the important *rôle* assigned to the torpedo boat by many naval officers. There can be no doubt that, when efficiently officered and manned by trained crews, they may, in the hands of commanding officers of reckless bravery, do considerable damage; but it must be remembered that the vessels which they are to attack are likely to be manned by just as skilful crews under the direction of as good officers, and, if Wainwright in the little Gloucester could so easily demolish two destroyers (even admitting that they were inefficiently handled), what chance would such vessels have against the much more powerful secondary battery of one of the big ships? These little vessels are highly interesting from an engineering standpoint, and every one interested in naval warfare will await an opportunity for them to show what they are worth when properly handled.

A word also about the monitors. These too, in a large degree, are vessels in which engineers may take special interest, and I am a great believer in their efficacy when properly used. In the Spanish-American war their record is considered to have been a poor one, but this, in my judgment, was because they were diverted to uses for which they were never intended. They are purposely designed for operating near the coast, and have neither the speed or the coal-supply to enable them to make long cruises. This was the cause of the complaint that Sampson's movement against San Juan in Porto Rico was so greatly hampered by the monitors. It goes without saying that so able a commander as Admiral Sampson would never have taken the monitors on such a trip unless it had been absolutely necessary on account of the small number of battle-ships and the importance of utilizing the powerful guns of the monitors. At a recent meeting of one of the American technical societies a gallant captain of our navy, and a personal friend of the writer, who has had great experience with monitors from having commanded one for a considerable time, stated that, if given the command of the Monterey, he would be ready to fight any battle-ship afloat. I certainly do not advocate the building of monitors to the exclusion of vessels intended for the high seas, but as coast-defenders I believe they have no superiors.

It is very gratifying to be able to say that, in the main, the machinery of the United States vessels during the late war gave excellent satisfaction. This was due, of course, to the painstaking care bestowed by the officers in charge of the machinery, but it shows also that the machinery was well designed and of excellent material and workmanship. The famous trip of the Oregon is familiar to every patriotic American, and she made a record which will not easily be surpassed. After being under steam constantly for nearly three months, and covering a distance of about fifteen thousand miles, she was able to go at once on the blockade at Santiago, and in the fight of July 3 was the most important factor in the great victory. On that occasion she surpassed her trial performance in power, and almost equaled it in speed, in spite of a much greater displacement and a foul bottom. The ability to attain so wonderful a result after so long a period, without overhauling, is just cause of pride for all concerned in the design, building, and maintenance of this magnificent fighting machine.

One of the lessons of the war which is worth noting was developed from the use of a number of merchant vessels, armed with light guns and called "auxiliary cruisers,"—namely, that there is a material difference in construction between the machinery of naval vessels and that of the merchant marine, and that the engines of merchant vessels are not entirely adapted to the conditions of naval service without important additions. This is only natural on account of the difference in the duties of the two classes of vessels. The merchant steamer makes her trips under absolutely uniform conditions, while the naval vessel must be ready for constant manœuvring. As already remarked, the modern naval engine does nothing but drive the propeller, the working of the pumps and other auxiliaries being left to auxiliary engines. This is not the case with the merchant engine, and it was soon found that vessels of this class required additional pumps to keep their condensers clear of water while the vessels were lying under steam, ready for use at short notice. It was found also that very few of the merchant vessels were fitted with evaporators, having always run between ports where fresh water of excellent quality could be obtained in large quantities, and possessing the capacity for extra boiler-feed in the double bottoms.

Before war was actually declared, and as soon as it became imminent, a plan long formed was carried out,—that of equipping a vessel as a floating machine shop; this gave us the vessel known as the Vulcan. Plans for such a vessel had been prepared some years ago, when war between the United States and Chili seemed imminent, so that it was necessary only to modify the original plans to suit the ship that was purchased. It was almost certain, *a priori*, that such a vessel would be of the greatest service to the fleet, and actual experience with the Vulcan has confirmed all expectations. Every officer in the American fleet at Santiago, from the admiral down, has praised the usefulness of this vessel. Space will not permit the giving of a complete list of her tools, but it may be said that her equipment was equal to that of any but large repair-plants on shore, and the work actually done by her covered almost every conceivable part of the machinery of a war vessel, including repairs to hulls, gun mounts, dynamos, main steam pipes, main piston rods (for small ships), brass castings without number, and a considerable quantity of iron castings. This last is an especially interesting feature, as it is believed that the Vulcan is the first vessel ever fitted with a cupola for making iron castings. The object of such a ship is readily seen; it enables the vessels to have every repair, short of a breakdown of some of the larger parts, made on the station, when otherwise they would have been compelled to go at least several hundred miles, and in some cases more than a thousand, to reach a repair-yard. The Vulcan also carried an enormous supply of engineering stores, which proved of the greatest value. Provision had been made in other navies for vessels similar to the Vulcan, but this is the first case in which one was used in actual warfare.

It became evident at an early stage of the blockade that the problem of supplying an adequate amount of fresh water for the boilers was an important one. With the high pressures now carried it is absolutely necessary that only fresh water should be used in the boilers, and the ordinary evaporating plant, because of limitations in space, is sufficient only for ordinary cruising with a portion of the boilers. Key West has no natural water-supply, except rain, and the reservoirs were soon emptied. A multiple-effect distilling plant was installed there to remedy the natural deficiency. Before this, however, arrangements had been made to equip vessels as distilling ships, and two of them have been fitted out—the Iris and the Rainbow. Each of these has a triple-effect distilling apparatus with an average capacity of about 60,000 gallons per day. The Iris showed, on a test, with clean heating-surface, a capacity of more than 70,000 gallons of potable water and more than 100,000 gallons of water fit for boiler use. These vessels are fitted with a tank-capacity of about 1,000 tons, and carry a coal-supply of about 3,000 tons. They are thus particularly valuable adjuncts to a modern fleet, being at once a source of supply of both coal and water, the latter normally and the former in an emergency where coal would be more important than water. Unfortunately neither of these vessels was completed until the naval part of the war was over, and, on account of the lack of fresh water, there was trouble on several ships with collapsed furnaces, due to the formation of scale in consequence of the forced use of salt water for extra feed. It seems very probable that vessels of this class will, like the repair ships, be a necessary addition to a modern fleet operating away from a base where fresh water can be obtained in large quantities.

The experience of the war enforced the importance of another fact, which would be very obvious on consideration,—namely, that there should be adequate provision for a trained engineer force on which the navy may draw in time of war. A great deal has been done in the United States towards the organization and training of a naval militia as an auxiliary to the navy, and the men of this organization rendered valuable service during the war; but, except to an extent so slight as to be almost negligible, no effort had been made to supply trained men for the work of the engineers' force. As a result, a very large proportion of the men who volunteered were absolutely green, and many of them had had no experience whatever with any kind of marine machinery, having never been either to sea or on board a ship of any kind. One of the younger officers of the engineer corps, who was the chief engineer of the Merrimac, wrote some exceedingly amusing letters about his experience on that vessel when she was first commissioned, the fact developing that, out of his whole crew, only one man had ever before been on a ship. He likened their astonishment, when the engines were first turned over after considerable difficulty, to the open-mouthed wonder with which a crowd at a country fair views a balloon ascension. So far from casting ridicule upon the brave and self-sacrificing men who, absolutely strangers to the conditions of naval life, volunteered for it, I cite this case only to show the mistake which has been made in not providing adequately for a trained engineer division of the naval reserves. The need is obvious enough of such an organization among the engineers, mechanics, and firemen of our merchant service, who are accustomed to marine machinery and have the sea habit, as will enable the government, on occasion, to man the engine and fire-rooms with these men, who will need only a short training to make them feel at home and render highly-efficient service.

One lesson which this war has thoroughly taught is the vital importance, to a nation which would have an efficient navy, of the fostering of the mechanical instinct. Americans may be proud of being a nation of mechanics, and I attribute the overwhelming victories over the Spaniards largely to this fact and the absolute lack of any mechanical aptitude on the part of the opponents. It is a notorious fact, to those whose travels about the world have brought them in contact with Spaniards, or people of Spanish descent, that this race has never developed mechanical engineers of decent ability, and that the mechanic, in fact, is scorned, instead of being honored and respected. The utter failure of Cervera's fast armored cruisers, which had trial speeds of 20 knots, to escape from the United States vessels at Santiago, none of which were making 17, shows the disastrous results of discouragement of the mechanic. As we now know, the condition of the two fastest ships at Santiago, the New York and Brooklyn, was such that only half power could be used immediately, and it seems almost certain that, had Cervera's ships been able to make their maximum speeds, they would have escaped. The mechanical instinct, too, is just as important for the care and manipulation of the modern guns and turrets as for the care and manipulation of the motive power, and I believe that in this respect also the mechanical aptitude of the American people was an important factor in the victory.

The object of a naval vessel is to perform her full duty in the hour of battle, and, unless the performance in this crucial time is satisfactory, the vessel must be considered a failure, however admirable from other points of view. The war which has just ended was so one-sided that many are inclined to think that, from some points of view, many questions still remain unsettled. So far as the machinery is concerned, however, the test seems to have been thorough, warranting the conclusion that the work hitherto has been on correct lines, and that the work done by the machinery during the war was excellent. So far as can be now seen, there does not seem any probability of immediate changes so radical as the sudden jump in pressures from the compound to the triple-expansion engine, the great increase in rotational speeds, and the abandonment of the cylindrical boiler for the water-tube boiler, which have already taken place. The remarkable performance of the Turbinia in 1897 aroused great interest, and some of the more sanguine look to the steam turbine as the next great improvement in marine engineering. So little is known of the details of the Turbinia, and the data that have been published are of such a nature, that it seems improbable that the steam engine will be displaced by the steam turbine very soon, if at all. The demand will continue for higher speeds, and this means further reduction of weight per unit of power. There will also be a steady effort for an increase of economy. These desiderata will give designers scope for the exercise of their talents.

It is evident that the United States navy is destined to a great expansion, and this will demand for its highest efficiency a highly-trained personnel. The naval personnel bill, recently before the United States congress, will make all the officers concerned with the management of the men and the direction of the vessel and her motive power engineers as well as deck officers. This I believe to be only the first step towards the organization of the navy in accordance with the conditions now obtaining, and the next step will be the making of every enlisted man a mechanic as well as a seaman. This is exactly similar to the change which occurred many years ago, when the sea-soldier and the sailor, both officers and men, became amalgamated ; and it will give us not only the fighting engineer as our naval officer, but the fighting mechanic for our man-of-war's man.

AMERICA AND GERMANY AS EXPORT COMPETITORS AND CUSTOMERS.

By Louis J. Magee.

II.—ECONOMIC LEGISLATION, AND ITS INFLUENCE ON INDUSTRY.

ENGINEERS should not refrain from expressing their opinions on this subject simply because they are not professional economists ; for, if, on the one hand, the economists are free from partiality for any one branch of trade or industry, it is equally true that they are not conversant with the practical considerations which underlie statistics.

The conservative—agrarian—element in Germany is in opposition to the liberal element in that it demands a tariff highly protective, especially of food stuffs, opposes commercial and tariff treaties, and, in general, fails to realize that the fostering of German export industry is a fundamental condition of the nation's prosperity. The emperor sees that the agrarians about him are on the wrong track. He meant a great deal when he said : "Our future lies on the seas."

Considering the three great groups into which the income of the German custom house is divided, the value of the duties received in each group, with reference to the estimated value of the articles imported, shows for 1897 a duty of 1.3 per cent. for raw materials used by the industries, 11 per cent. for manufactured goods, and 21.1 per cent. for food stuffs. The total amount of duties collected in that year, 475,000,000 marks, is 10.1 per cent. of the value of the imports. If we now exclude all articles which are free of duty, we find that the duties collected amounted to 18 per cent. of the value of the dutiable imports. Considering only the dutiable articles in the three groups above mentioned, raw materials are found to have paid a duty of 7.02 per cent., manufactured goods 16.05 per cent., and food stuffs 22.74 per cent.*

From these figures, which agree fairly well with the average of the last few years, it is evident that the agricultural interests of Germany are protected in a higher degree than are the manufacturing interests, and that the industry has the advantage of practically a free introduction of its raw materials.

Per capita of the population the duty paid for grain in 1897 was 2.51 marks ; for petroleum, etc., 1.18 marks ; for coffee, 1.01 marks ; for wine, .28 marks ; for iron wares, .091 marks ; for machinery, leather, wooden wares, eggs, tea, horses, and cattle, about .046 marks.

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* *Statistisches Jahrbuch für das Deutsche Reich*, 1898.

Now, the manufacturers, differing in their ideas as to the extent of tariff protection, according to the influence of foreign competition on their respective branches, seem to agree in general upon the desirability of stable trade relations with foreign countries guaranteed by commercial treaties. The present tariff is being revised, and, although a new one cannot come into force until the existing commercial treaties expire (1904), the revision will be used as a basis in negotiating new treaties before that time. The present tariff is too general; it needs to be specialized according to modern requirements. Without giving up the principle of a tariff based on weight, and without going so far in specialization as to lose the advantages of a classification which leaves room for every conceivable article, a great deal may be done to make the present form of the tariff more equitable and rational.

At present, bicycles and rifles fall under the general position of fine iron ware, but the value of these articles is much higher in proportion to their weight than the framers of the tariff thought it likely to be. The result is that bicycles pay only about 1.9 per cent. duty, and rifles 4.5 per cent., while rough iron castings pay 21.7 per cent., tin-plate about 20 per cent., iron and steel wire 10.3 per cent., tools 10 per cent., and machinery in general 2.5 per cent. to 7.1 per cent. —sewing machines, for instance, paying only about 2.5 per cent. While equality was not intended, such discrepancies as these are clearly unreasonable.*

The ministry of the interior formed a commission of thirty members from the agricultural element, trades, and industries, to advise the government on the revision of the tariff and the preparation of future commercial treaties. The majority of this commission is for protection. Independently of this commission, important representatives of commerce and industry have created a central office to receive and work out all suggestions and statistics with a view to safeguarding their interests as opposed to those of the agrarians.

Just as the United States have enjoyed the advantages of internal free trade among States whose laws and customs, needs and resources, vary most widely, so in the last quarter of this century Germany has had the advantage of free trade among the widely-varying peoples within its imperial borders. Great Britain, lacking an internal empire, had long ago to adopt the principle that political boundaries have nothing to do with commerce, seeking its markets abroad and buying of all the world. Now that Germany and the United States have gotten beyond the point where internal free-trade furnishes enough purchasers for the products of highly-developed industries, they, too, must sooner or later follow England's example. Germany has developed as an industrial nation without a highly protective tariff; one industry after another has grown up without protection, urged on by the promising prospects of a market supplied for the time being from abroad. With modern facilities for transportation there is no reason why every political division of the earth need foster the production of every necessary article on its own soil. If the Swiss have made a specialty of cheap and good watches, there is no reason why the people of Germany should not be as free to purchase them as watches made, say in Baden, nearly as far away from the centre of Germany as Switzerland,—in fact, just within the imperial border. The Germans are manufacturing excellent watches, but it is certainly to the advantage of the people that they are not obliged to go without watches or take what the German factories can give them for their money, just for the sake of inviting the participation of a few million marks more of capital in the watch industry and an eventual overproduction.

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* *Stahl und Eisen*, November 22, 1898.

As opposed to the oft-quoted instance of the sudden development of the tin-plate industry under high tariff protection in the United States, it is interesting to note a case where a tariff left low intentionally had the effect of developing an enormous industry in Germany. At the time of the framing of the present German tariff, in 1879, the manufacture of machines for the textile industry, or of any machine for that matter, was not very highly developed. German spinners and weavers were obliged to get their machines from England, as they do largely to-day. Thus having the advantage of English experience, and being free to import English machines, the Germans have developed a textile industry which exported goods to the value of about 776,000,000 marks in 1897, or about 20 per cent. of the total exports. In the making and selling of this branch of manufactured products vastly more hands are occupied and more capital invested than there would be, had the importation of those early machines been rendered difficult by high duties. To-day the textile industry is purchasing a part of its machinery from England, a part from Switzerland, and some types exclusively from Germany, according to the specialties developed. This state of affairs was brought about perhaps by the accident of invention; perhaps by the peculiarity of the raw materials used in each case, the local methods of working, or the characteristics of the laborers,—*naturally*, in any case, and not *artificially*, by a high tariff.

In addition to the customs, the German government has a revenue of about three-fourths as much more from the taxes on beer, distilled liquors, tobacco, salt, and sugar. Stamps on bills of exchange, contracts, bills of sale, playing-cards, and lottery tickets produced a revenue of 60,842,000 marks in 1897, one-third of this sum coming from lotteries alone. Contracts closed in Prussia must be provided with a stamp of a value of from one-tenth to one-third of one per cent. of the materials to be delivered or the values involved, exclusive of labor. Government auditors make frequent visits at short notice, and look through the contracts, so that great precision and caution are customary. This seems a source of income which has least of all the appearance of oppression, as a stamp revenue is indicative of a corresponding profit for those who pay it.

The German laws for stock companies protect the public investor very strictly. Printed annual reports of managers, approved by the boards of directors, are compulsory, and free to the public. Stock companies are not registered without previous careful examination, and, in cases where patents or manufacturing experience are given in return for a certain number of shares, it is expected that the latter shall form only a comparatively small part of the capital. In general, I think that German financiers consider American methods less secure than their own, because of the lack of unity in the corporation laws in various States of the republic, and because stock companies are sometimes not sufficiently protected from the danger of improper management by limitations on the power of the individual.

Contrary to the practice in America or England, manufacturing establishments of all kinds, inventions, street railways, and lighting and power plants are financed and founded, or bought up and reorganized, by banks and banking groups. In England the public responds directly to the invitation of the promoter or inventor. In Germany the bank must sign its name first, to inspire confidence. The bankers and great *chefs d'industrie* are conservative, yet courageous; economical, yet liberal. They insist upon rating assets at the bed-rock value. They prefer to write off more for depreciation than the laws dictate; they oppose measures which could weaken the credit of their companies. Not forgetting, of course, their own profit, they risk their financial reputations at this business of promoting industries. Out of 294 industrial companies selected from those whose shares are quoted on the Exchange of Berlin, 94 companies paid in 1897 dividends of from 6 to 9 per cent., 84 paid dividends of 10 to 14 per cent., 35 gave 15 to 19 per cent., 12 gave 20 to 25 per cent., and 7 companies paid a still greater dividend. Only 21 per cent. of all the companies paid less than 6 per cent.

The great industrial boom, with its attendant craze for the formation of new companies, is expected by many conservative Germans to be followed by a great falling-off in business, due to over-production, etc. But no signs of such retrogression are at present noticeable.

One cannot help feeling that the present prosperity rests on a good foundation under the German system,—a system where managing directors are so often hauled over the coals by intelligent supervisory boards, where assets are so closely examined, and where the possibilities of future losses are so conscientiously discounted by reserves equally fair to the present and morally due to the future stockholder.

The insurance department of every great industrial house plays an expensive, complex, and interesting *rôle*. First of all comes the Imperial Fund, for age and invalidity (established in 1889), to which all employees earning less than $500 per year have to contribute, the employers paying an equal percentage. This fund provides for a pension due after the seventieth year, or in case of invalidity not due to accident. In 1897, 452,300 pensions were paid.

Second comes the accident insurance, for all employees earning below $1,250. This system, called the "Berufs-Genossenschaften," or Employers' Liability Associations, is semi-official, and is supported entirely by employers, who are obliged to pay a certain percentage on the amount of their wage-list, varying with the number of accidents. There are sixty-four of these associations for industrial, mining, and marine, and forty-eight for agricultural, pursuits. To them are to be added the State employees on the railroads, postal department, etc. These associations pay pensions to widows up to 60 per cent. of the wages of those who meet death by accident, and pay all other costs resulting rom accidents, as far as such are adjudged by the courts. In 1896 these institutions had to deal with 7,101 cases of death and 86,403 cases of injury, distributed among about 17,000,000 persons.

Furthermore, for those employees who receive a salary of more than $1,250 per year it is customary for the firms to take out a collective insurance against accidents happening in the course of their occupation. This is arranged by the firms with private insurance companies, as is also a further general liability insurance covering the firm for all liabilities arising from accidents to employees or outside parties,—for instance, people who are run over by electric cars.

There is still another institution, called the "Kranken-Casse," or Sick Fund, established in every town and city. Any firm employing more than fifty hands may establish one for itself, under government control. All employees receiving less than $500 per year contribute to this fund, which serves for medicine, surgical attendance, hospital expenses, etc., up to the extent of one year's illness. The contribution amounts to about 2¼ per cent. of the average wages, and one-third of this is paid by the employer, two-thirds being paid by the employee. About eight millions of persons are enrolled in this department of insurance.

The present session of the German reichstag will take action on a question which has a most important bearing on the freedom of the laborer. The emperor referred in strong terms to the preparation of some such legislative act, in a Westphalian speech in the summer of 1898; and he touched upon the matter again in his address on the occasion of the opening of the reichstag in December, 1898, as follows:

> The terrorism by which those who are willing to work are hindered from the continuation of their work or from accepting new work has assumed dimensions harmful to the common weal.
>
> The right of coalition (for strikes) granted to laborers will not be in the least altered or weakened, but this right must not be misused by threats and intimidations to crush down that higher right,—namely, to work and live from work.
>
> It is, according to my conviction and that of the leaders of these Confederate States, the absolute duty of the State to protect personal freedom and free will; but the law and punishments at present existing to cover such cases are not sufficient; they need to be extended and completed; and I trust that you will not fail to signify your agreement with the law which has been drafted for the protection of the workmen in this respect.

During the last few years a large number of cases have come up in which it was impossible, according to law, to mete out justly-deserved punishment to those doing violence in times of strikes. The new law is supposed to contemplate extremely severe dealing with the instigators of strikes and all persons who come between the employer and the laborer. These sharp measures are likely to call forth great opposition from the Socialist party.

German patents are especially valuable, because the search for previous publication is, comparatively speaking, thorough. The government takes no responsibility, however, for the correctness of its examination. The claims are also reduced to a minimum of conciseness. The public are invited to produce evidences of priority, or otherwise attack the claims of the inventors. To this end the papers are publicly exposed for six weeks after the patent office has finished its examination and before the patent is definitely granted. Much patent litigation is probably thereby avoided, and the public is less likely to be led into investments based on patents lacking in novelty and unable to withstand the attacks which commercial success is sure to call down upon them. If a patent can exist five years without being attacked, it is sure of the rest of its term. A high technical authority* criticises the German patent office as lacking in experts with practical knowledge, one-sided in its views, careless in its examination, and lacking in uniformity as to the fundamental principles of patent practice in its various departments. Despite the importance of this critic, a comparison, were it possible, would probably show that the German patent office has kept pace with industry as well as could be expected. He is certainly justified, however, in calling attention to insufficient examination for novelty. Americans have frequently entered into negotiations for the sale of inventions which they believed to be as well protected by the German as by the United States patents, only to learn ultimately that some unimportant detail alone had been covered in the claim. Inventors should personally assist their agents in answering the objections of the patent office and explaining points which the examiners fail to understand. German patents have an important influence on the decisions of other European offices, while Belgian and French patents are allowed without examination as to novelty.

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* Prof. Riedler: *Zeitschrift des V. deutscher Ing.*, No. 48. 1898.

As to the bad feeling which has recently existed between Germany and America, Ambassador White, speaking from a long experience with Germany, where the respect for him is not confined to official circles, said publicly: "I believe that the feelings of the great majority of the thinking German people are friendly toward us, and this great majority have the wit or the instinct to discern the real reasons for any injustice that may be done our country by individuals, ... and I declare my full faith that, whatever prejudices may affect any of the German people for a time, we may confidently count upon the final supremacy among them of right reason and justice."

Along with the high appreciation of the accomplishments of Americans as a nation, there is probably a well-restrained dislike of Americans in some circles in Germany. Certain branches of industry can hardly help some feeling against their republican competitors. The recent importations of American iron and machinery are certainly not calculated to smooth the feelings of certain classes of manufacturers. They feel embittered that they have not a better chance of selling to America, and forget very naturally how their colleagues in other branches of industry live on American trade. All the machinery sold in 1897 to Germany by the United States, including the much-berated bicycles, does not equal in value, for instance, the one item of German gloves imported into the United States. Instead, however, of allowing ill-feeling to continue, let us rather wonder that Germany has not already put up more barriers against the United States; let Americans show their love of fair play in the international market, and not restrain the admiration they must certainly feel for a nation which, without natural advantages such as theirs, can work up an export balance of manufactures amounting to $318,710,000 while keeping an army of 585,000 men up to the highest point of physical and scientific training.

RAILWAY LOCATION AND SURVEYS IN RAJPUTANA, INDIA.

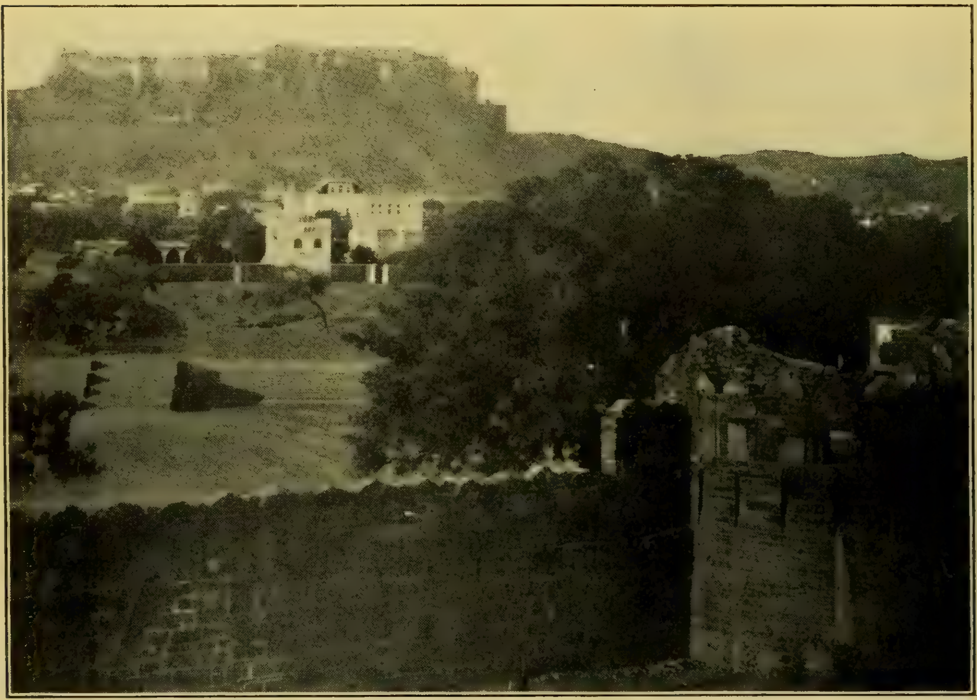
By C. H. Croudace.

IN a paper entitled "Some Features of Indian Railways," in the July number of THE ENGINEERING MAGAZINE, allusion was made to the prompt and economical manner in which railway surveys are carried out by the government of India. The Delhi-Kotri project of 1889–90 is an example of a long line of survey carried through expeditiously, and, now that such surveys have to be undertaken on a large scale in China and elsewhere, an account of it should prove interesting to engineers and promoters.

The idea of connecting Karachi to Delhi by a direct line (in lieu of the circuitous Indus valley route) originated with Sir Bradford Leslie and others in 1887. They saw the importance of such a route, now increased by the old and also recent agitation for making Delhi the official capital of India and thus avoiding the annual exodus from Calcutta to Simla and back A reconnaissance of the route was forced on the government of India by the merchants of Karachi in the cold season of 1888–89, and reported on unfavourably by Mr. H. Bell. Nothing daunted, the Karachi merchants, led by the late Mr. McHinch, agitated for a detailed survey, offering to bear the expense. The government, however, decided to make the survey, which was entrusted to the writer. Special study was to be given to the great sand ridges in Sind, which were supposed to mar any practical project for a distance of one hundred miles, or about a fifth of the length to be surveyed.

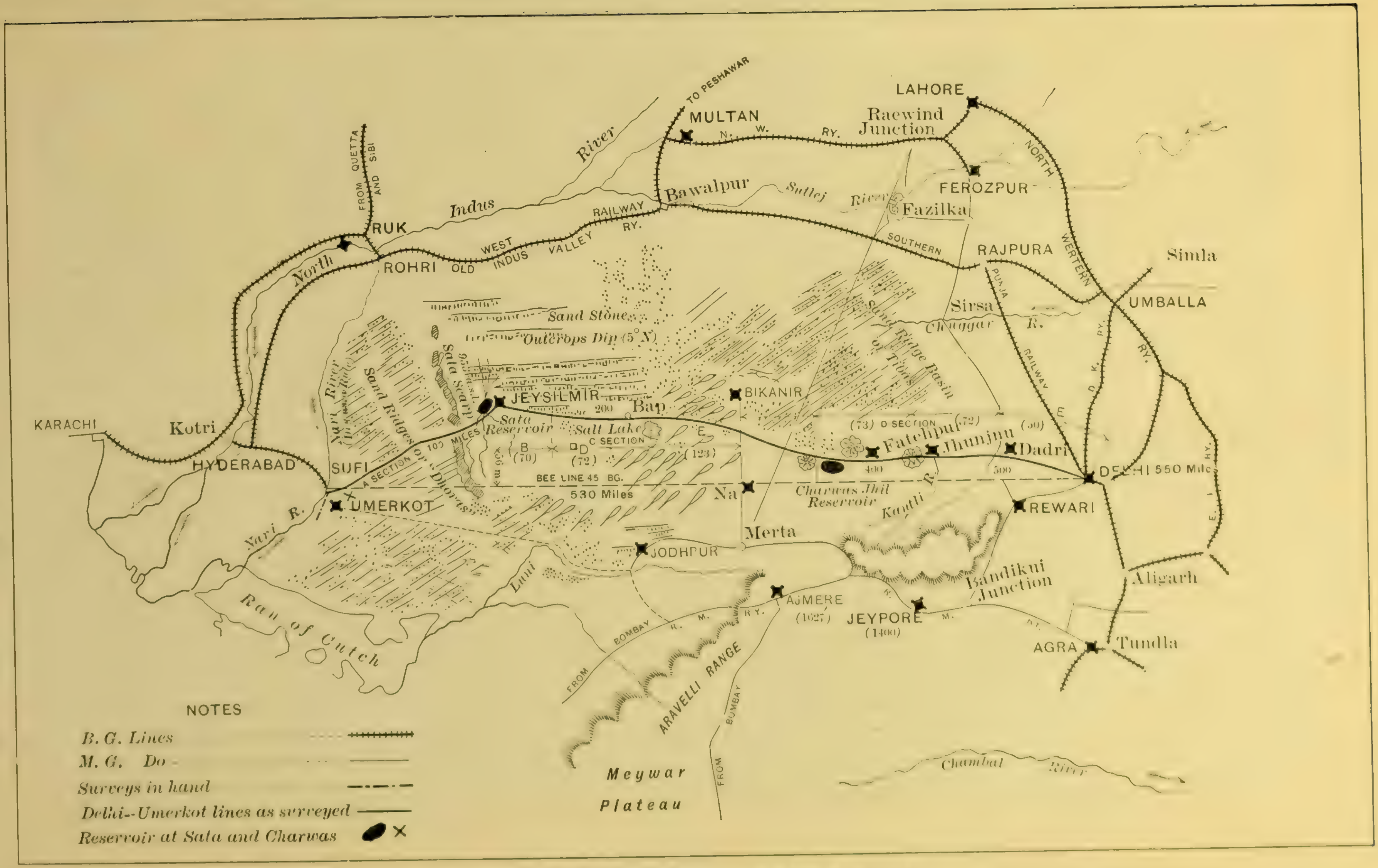
Prior to the reconnaissance little or nothing was known of this desert in an engineering sense, as the once-well-traversed trade route of 130 miles, running south-west from Jeysilmir, the capital of this desert State, to Umerkot, was gradually abandoned with the completion of the Indus Valley Railway from Kotri to Sukkur. The student of Indian history will remember that the emperor Humayon, the great Akber's father, was a fugitive through this desert, losing many of his followers from thirst, and that his son was born at Umerkot. A tablet erected to his memory by an English official marks the site of this event. Again, some of the chroniclers mention that heavy brass cannon were dragged with great difficulty over the sand ridges from Umerkot to the hill fortress of Jodhpur, some two hundred miles eastward. Even the ubiquitous survey department of India had not mapped out the country stretching from the sandhill-girdled fort of Umerkot on the west to the yellow-limestone-built city of Jeysilmir on the east, a length of one hundred miles. The nature and lie of the sand ridges were, therefore, unknown until reconnoitred by the writer in 1889.

To realize the location, draw a bee line on the map from Sufi on the Nara river (twelve miles west of Umerkot) to Delhi, a length of five hundred and thirty miles, with a bearing of 42°, or nearly due north-east. The route surveyed forms two sides of a very obtuse triangle on this base with its apex at Jeysilmir—*vide* map. The alignment is five hundred and fifty miles long, or only 3.8 per cent. in excess of the bee line,—probably the shortest alignment over a long railway in India. Starting from the west end, the line passes through Sind in a north-east direction for 50 miles; then through the native Rajput States of Jeysilmir, Bikanir, and Jeypore for 415 miles; and, finally, through 85 miles of British territory to Delhi, the terminus. The compass bearings are: north-east for 140 miles, and then east-north-east for 410 miles, to Delhi.



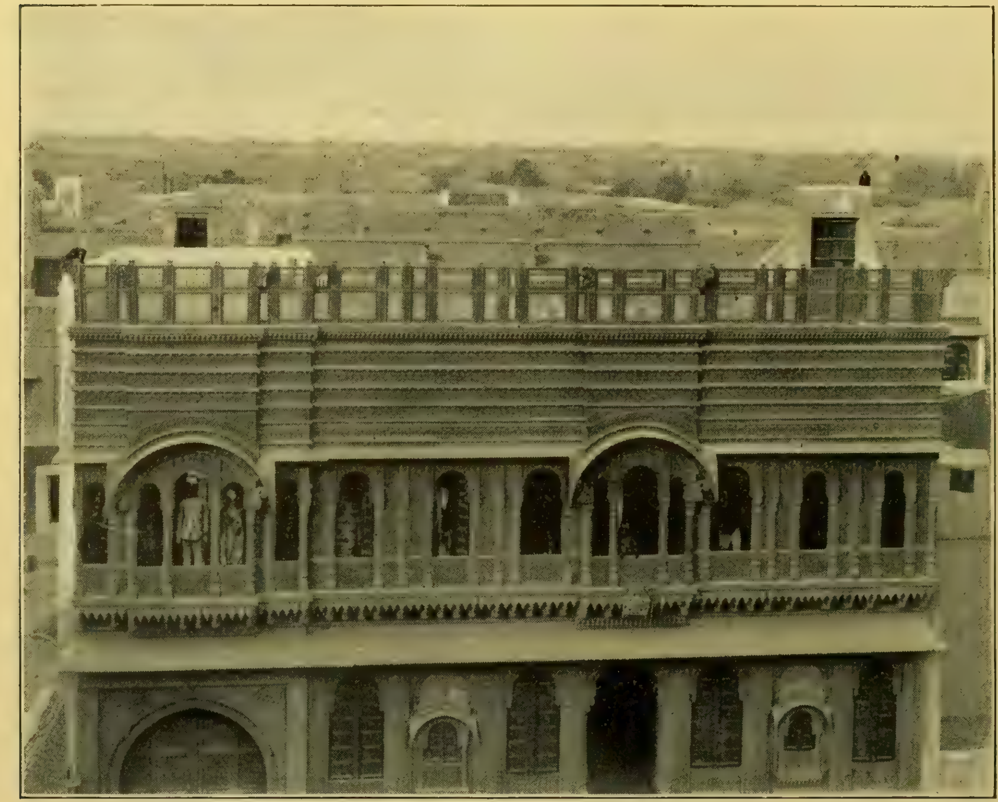
THE FORT, JODHPUR.

On the first 140 miles there are but two large stone and mud-built villages, each having a well 300 feet deep and containing brackish water. The other places passed are mere herdsmen's hamlets, built of conical-shaped wattle and dab huts, with rude folds for camels and cattle. From Jeysilmir (136th mile) to the picturesque and well-



MAP OF THE DELHI-KARACHI DIRECT RAILWAY.

built town of Futehpur the distance is 213 miles,—a long stretch of rocky or sandy country, with villages ten to fifteen miles apart. This town has a famous "Bowli," or underground, arched in reservoir, some one hundred and twenty feet deep, approached by a long flight of steps leading to arcaded stages,—the largest structure of its kind in India. The intervening villages depend for their water supply on wells averaging 400 feet in depth, worked often by four inclines with 16 pairs of bullocks, which haul the "citurus," or leather water-bag, up the inclines. When the bag has traversed two hundred feet, being then half-way up, a second pair of bullocks, in readiness at the top of the incline, pick up the rope for another run of 200 feet to the surface. The stone cisterns built around each well are a leading feature in village life, as the numerous herds of cattle, sheep, and camels have to be watered morning and evening.



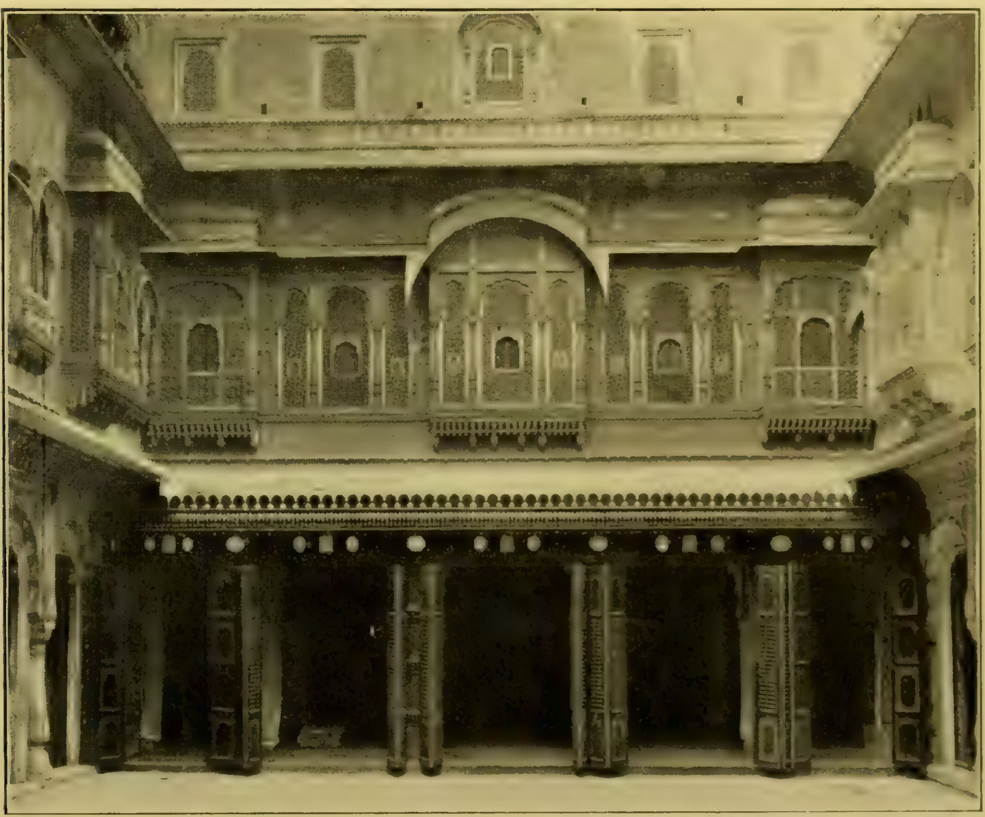
VIEW OF BIKANIR FROM THE ROOF OF A MERCHANT'S MANSION.
City walls in middle distance. The stone carving on the house is modern.

East of Futehpur the distance to Delhi is 150 miles, and some highly-interesting towns are passed. These towns are the retreats of the well-known trading class called the "Marwaris," who build their mansions, or "havelis," in these sandhill-locked oases, and retire to them to pass their declining years. Here in ante-railway days they were safe from unscrupulous rajahs or daring decoits bent on getting their hoarded treasures.

To avoid a long description of this project, this paper will deal only with two leading features,—the sand-ridge and desert country, one hundred miles in width, and the water-supply, carried out by means of high-level reservoirs and a pipe line three hundred miles in length.

The route surveyed may conveniently be divided into five sections (A to E), varying greatly in character, of which the most westerly is the most unique and interesting.

(A) *The "Dhora" country, or west section of 120 miles* (rising from 37 to 953 feet above sea-level). This length includes twenty miles of the irrigated plains of Sind, followed by one hundred miles of parallel sand ridges and narrow vallies, which rise abruptly two hundred feet from the plains, and reach one thousand feet at the east end. They may be described as the "fingers and knuckles" formation of sand ridges, locally called "Dhoras." These ridges are strictly parallel to each other, and vary from thirty to one hundred and twenty feet in height, being separated by intervals averaging one-third of a mile.


VERY OLD STONE CARVING IN THE PALACE, BIKANIR.

A 300-FT. WELL—THE DEEPEST IN BIKANIR. CITY WALLS IN THE BACKGROUND.

They spring from low cross ridges, or saddles, like closed fingers from the knuckles of the back of the hand, but in reverse and parallel directions. That is to say, the ridges face both north-east and south-west, covering a longitudinal distance of one to two miles, when they are again repeated in a similar formation. Their cross slopes average 2 to 1, and are well covered with desert grasses and bushes, an occasional acacia or rohira tree breaking the monotony of the landscape. They rest on a base of indurated soil called "pan," in which are occasional large areas of gravel and *débris* of dark

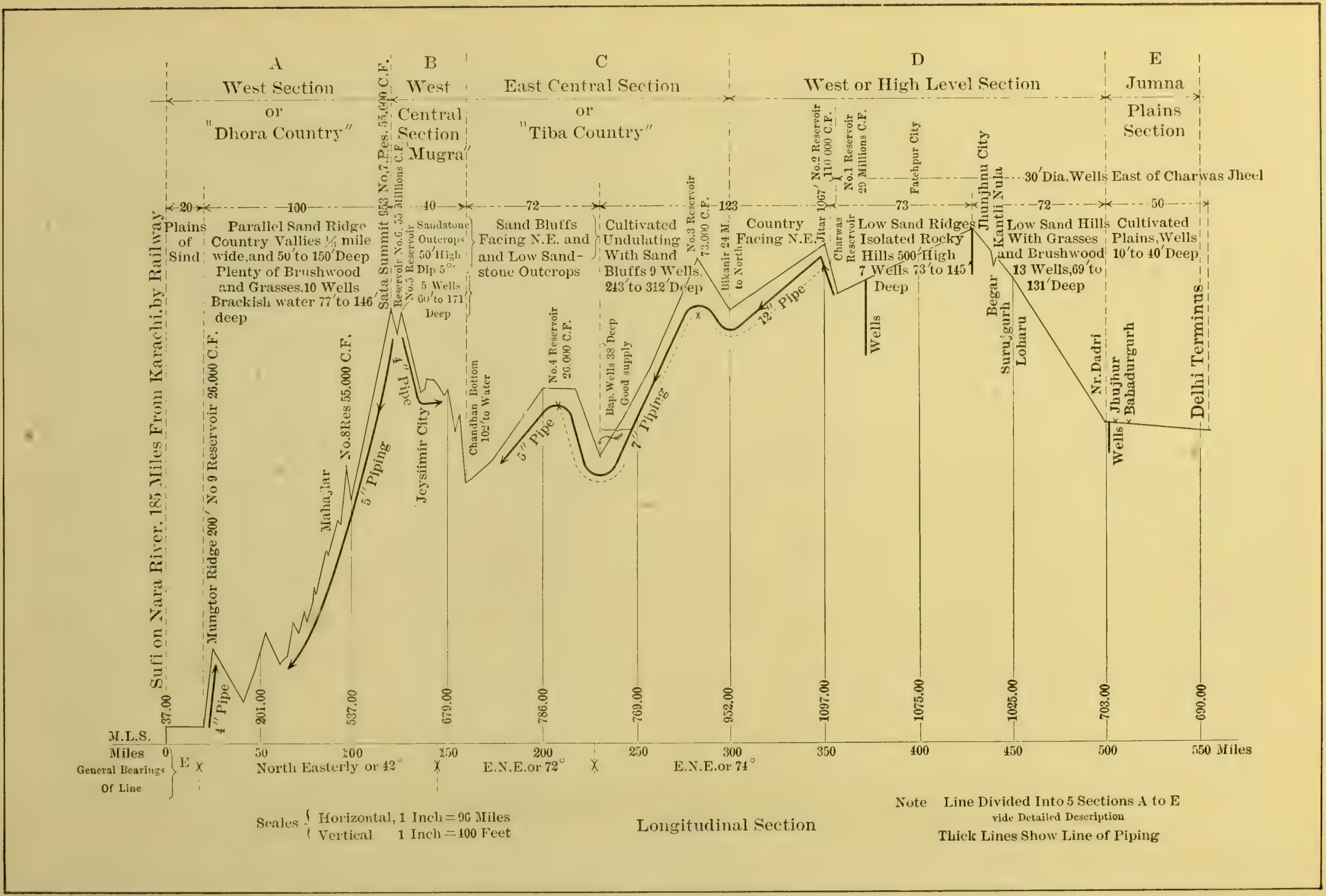
THE PALACE OF THE RAJAH OF BIKANIR.

brown, glistening, granular rock. This peculiar formation ends abruptly at the sandstone cliffs of Sata, about one thousand feet above sea-level, which form a barrier to their further extension eastwards. When seen for the first time from these heights, they have a confused wave-like appearance, and it is only ultimately discovered that they form in plan parallel, but tapering, ridges.

With the exception of the field rat, animal life is absent, and the old trade route is mostly indicated by the skeletons of camels, which dot the track at short intervals. The monotony is relieved by occasional bluffs, or mounds, from the top of which only similar trough-like vallies are observed. No nala, or even serviceable tank, is found, although the scoring of the surface indicates that there must be occasional heavy downpours. But, with all this, the country is the grazing-ground of numerous herds of camels, cattle, and sheep.

ON THE MUSHKAF-BOLAN RAILWAY.

(B) *The "Mugra" country, or west central division of 40 miles in length* (falling from 953 feet to 500 feet below sea-level). Here we enter into a different country altogether: a land of sheet rock covered with cactus bushes and rejoicing in one large, picturesque old town. It separates the western (*a*) and east central (*c*) countries by a tongue-shaped area, called locally the "Mugra," with its cliffs, or outcrops, fifty feet high, of alternating strata of reddish sandstones and dull yellow limestone, spaced one to two miles apart. They lie


A
West Section
or
"Dhora Country"
B
West
Central
Section
"Mugra"
C
East Central Section
or
"Tiba Country"
D
West or High Level Section
E
Jumna
Plains
Section
20
100
40
72
123
73
72
50
30′ Dia. Wells East of Charwas Jheel
Plains of Sind
Parallel Sand Ridge Country Vallies ⅓ mile wide, and 50′ to 150′ Deep Plenty of Brushwood and Grasses. 10 Wells Brackish water 77′ to 146′ deep
Sandstone Outcrops 50′ High Dip 5°
5 Wells 60′ to 171′ Deep
Sand Bluffs Facing N.E. and and Low Sandstone Outcrops
Cultivated Undulating With Sand Bluffs 9 Wells, 243′ to 312′ Deep
Country Facing N.E.
Low Sand Ridges Isolated Rocky Hills 500′ High 7 Wells 73′ to 145′ Deep
Low Sand Hills With Grasses and Brushwood 13 Wells, 69′ to 131′ Deep
Cultivated Plains, Wells 10′ to 40′ Deep
Sufi on Nara River. 185 Miles From Karachi by Railway
Mungtor Ridge 200′ No 9 Reservoir 26.000 C.F.
4″ Pipe
Mahajjar
No.8 Res 55.000 C.F.
5″ Piping
Sata Summit 953 No, 7. Res. 55,000 C.F.
Reservoir No. 6. 55 Millions C.F.
No.5 Reservoir
4″ Pipe
Jeysiimir City
Chandhan Bottom 102′ to Water
5″ Pipe
No.4 Reservoir 26.000 C.F.
Bap. Wells 38′ Deep Good supply
7″ Piping
No.3 Reservoir 73.000 C.F.
Bikanir 24 M. to North
12″ Pipe
Jitar 1067′ No.2 Reservoir 110 000 C.F.
Charwas Reservoir
No.1 Reservoir 29 Millions C.F.
Wells
Fatehpur City
Jhunjhnu City
Kantli Nula
Begar
Surujgurh
Loharu
Nr. Dadri
Wells
Jhujhur
Bahadurgurh
Delhi Terminus
37.00
201.00
537.00
679.00
786.00
769.00
952.00
1097.00
1075.00
1025.00
703.00
690.00
M.L.S.
Miles
0
50
100
150
200
250
300
350
400
450
500
550 Miles
General Bearings Of Line
E
North Easterly or 42°
E.N.E. or 72°
E.N.E. or 74°
Scales { Horizontal, 1 Inch = 96 Miles
Vertical 1 Inch = 400 Feet
Longitudinal Section
Note Line Divided Into 5 Sections A to E
vide Detailed Description
Thick Lines Show Line of Piping

SECTION OF THE DELHI-KARACHI DIRECT RAILWAY.

from east to west, with a dip of 5° to 10° to the north ; and advantage has been taken of the long inclines between these cliffs to form a gathering-ground for a fine tank at Jeysilmir City, where any sudden rainfall is safely secured, as the sheet-rock surface throws off any sudden fall of rain-water rapidly.

The picturesque city of Jeysilmir is built at the foot of one of these cliffs, with its north wall resting on their summit. The fortified palace of the "rawal," as the local rajah is called, stands above the plains on an isolated hill with precipitous sides, overlooking the dull-yellow, stone-built town, with its quaint Hindu architecture. The balconies of the houses, supported by richly-carved brackets, are very original and quaint in their treatment. The town is worthy of a visit, as is the larger city and hill-fort of Jodhpur some one hundred and thirty miles to the south-east and accessible by railway from Bombay. Rudyard Kipling gives a very interesting and original account of this romantic Rajput city. Again, some one hundred and sixty miles east-north-east of Jeysilmir and twenty-four miles north of the railway route (at three hundredth mile) is the equally interesting city of Bikanir, the capital of the small Hindu State of the same name. The high walls are some five miles in girth, and the rajah's noble palace lies outside the city walls ; it is one mass of turrets, domes, and projecting balconies. The chocolate-colored stone buildings are similar to those in Jodhpur. Outside these three cities are the ancestral tombs of their rajahs. They take the form of beautiful marble domes, supported by octagonally-planned pillars richly carved and raised on high, square-panelled plinths. The Hindu custom of "Sutti," or the burning of the widows on the husband's death, as many as a dozen at a time, is indicated by upright gravestones placed underneath the dome of each rajah's tomb. Returning to the Mugra coun-

THE COOMAR MAHARAJAH RESIDENCE, JODHPUR.

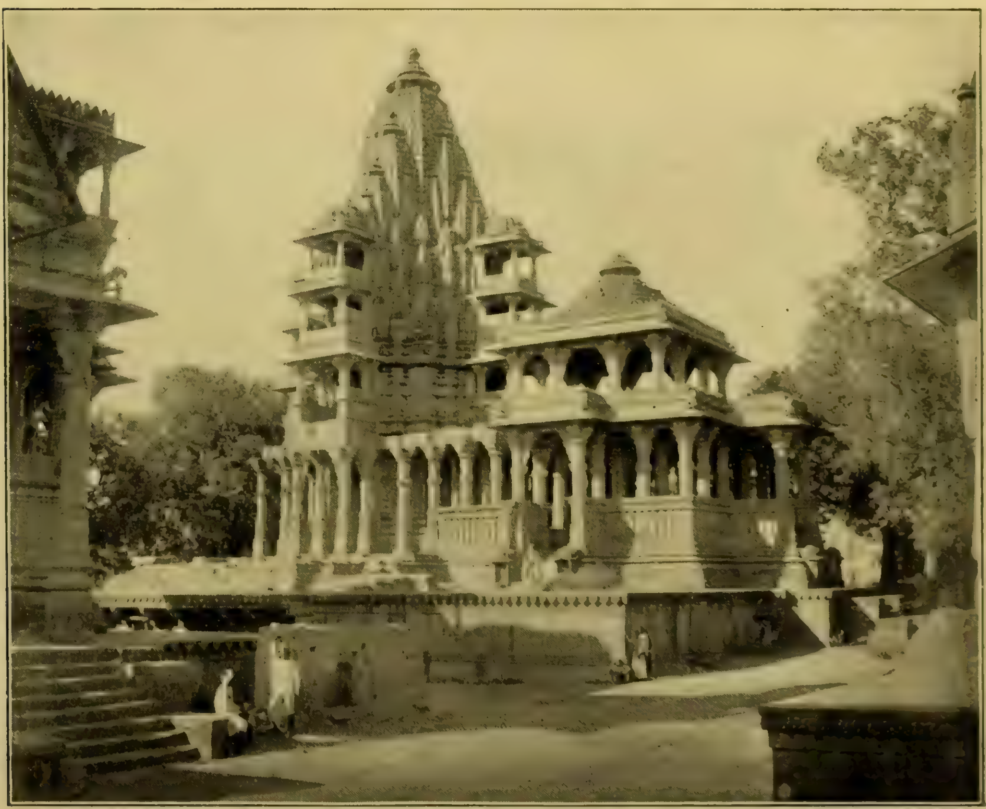
VIEW IN THE CITY OF JODHPUR.

try, it should be noted that, in spite of the scanty rainfall, this sheet-rock area forms a unique gathering-ground for a large reservoir, which can be fed by a torrent discharging in the rains 4,300 cubic feet of water per second for six hours. The nala forces its way through a gorge, and an unsuccessful attempt was made to dam it by the rawal of Jeysilmir. The dam was built of ashlar blocks, easily worked from the surface rock, and set as a dry wall backed by earth.

But, alas for the poor desert State! the first floods breached the dam in many places. It was by chance that the writer noticed the *débris* when riding on camel-back along the jungle track on the first reconnaissance; but, when he had to work out a water-supply for this project, the nala's importance was recalled to his memory by the havoc it had played with the dam. To meet the estimated requirements of the train service it was found necessary to design a reservoir capable of holding 55,000,000 cubic feet of water,—a sufficient supply for six years, the maximum period that the nala was known to withhold its precious flood-waters. By means of a reservoir on a summit near by, water can be supplied by gravity through piping to the railway in each direction, as indicated in the longitudinal section. Pending its completion, the pipe-line would feed the work with water forced up from the Nari river, near Umerkot.

(C) *The "Tiba" Country, or east central section of 140 miles in length.* (Mean height, 700 feet above sea-level.)

This region may be called the "whale-shaped" (in profile) sandhills area; for, when viewed at a distance, these detached ridges resemble a shoal of huge whales, with their heads and bodies pointing invariably north-east. They also resemble the tip ends of high banks rising out of the plains with a longitudinal slope of 1 in 50, extending in length from a quarter to half a mile and ending in bluffs or rounded ends 60 to 120 feet in height. They are in marked distinction to the Dhora country west of Jeysilmir (section A), as there is an entire absence of defined vallies and cross ridges into which the former merge or die out. Prior to being clothed with grasses, the tip ends increased in height and length by the prevailing south-west winds, which fed their bluffs in the fine, loose sand. It has struck the writer that the Surrey sand bluffs extending from Hambledon and Whitley to Leith Hill, a distance of twelve miles, were originally formed in a similar manner. A plateau of gneiss and schist rocks, twenty miles in width, separates two marked depressions at Chandwan and Bâp, seventy miles apart, in which a constant supply of sweet water is found at the respective depths of one hundred and forty feet. This fact points to some underground supply from a



THE MUNDOOR TEMPLE, JODHPUR.

distance, perhaps as far as the Indus, some hundred and fifty miles to the north. The brackish wells elsewhere are from 240 to 310 feet in depth. Indications of coal and lignite have been found and reported on by the geologists, and even a deep trial-boring has beeen suggested to the government of India.

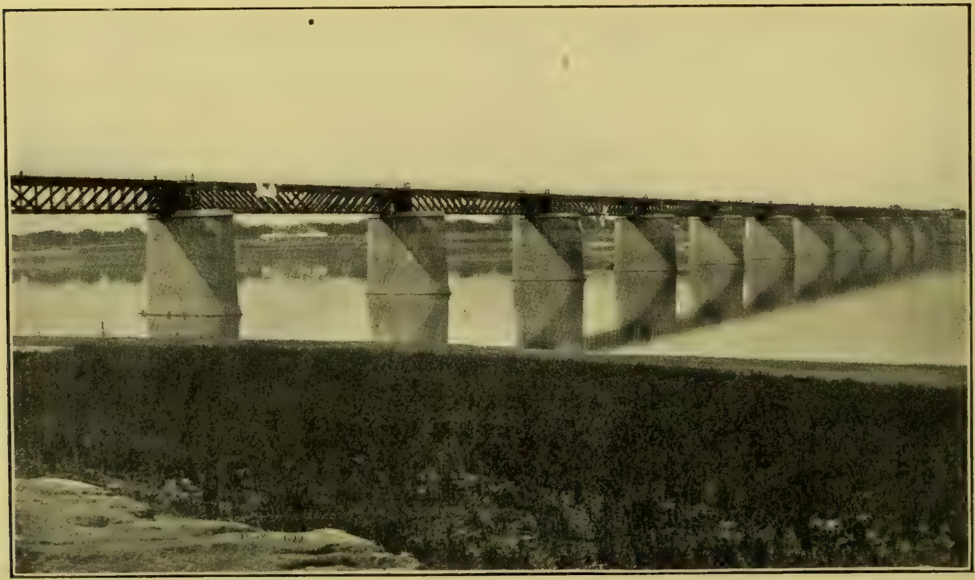
(D) *High level, or west division of 200 miles* (1,100 feet above sea-level).

The western side of this country is the highest on the line, averaging 1,100 feet above sea-level.

The sand ridges are more subdued, rising scarcely forty feet, and the low vallies widen out.

Two conspicuous conical hills, rising five hundred feet above the plains, are remarkable for their old copper mines. It is an interesting fact that a properly-organised line of heliograph signals is kept up from hill top to hill-top, in various directions, by means of which the inhabitants of Futehpur keep themselves familiar with what is passing in the outer world.

Grasses and dense, thorny bushes protect the surface; among the latter is the "Bher" bush, with its small, red berry, which is a very fattening food for the small, but hardy, sheep reared in great numbers.



BRIDGE ACROSS THE JUMNA RIVER AT ALLAHABAD.

The most interesting feature, however, is a shallow lake, the Charwas Jhil (at three hundred and sixty-third mile) some three square miles in area, with two feet of water and containing about 140,000,000 cubic feet. In this case, again, periodical scarcity of water has to be dealt with, but the interval is as long as twenty years. A storage of two years' supply is provided in the estimates, and a reservoir of

30,000,000 cubic feet is proposed. This supply will meet the requirements of two hundred miles of railway, furnishing 76,785 cubic feet per mile per annum, amounting to a total of 15,250,000 cubic feet, having a low-tide supply of the same quantity for the rare exception of a bad or rainless year. At the eastern end of this section the second river occurs, separated by a distance of two hundred and seventy-eight miles from the karkana nala near Jeysilmir. It is 1,200 feet in width, and has a heavy discharge during rains, but the flood-waters lose themselves in the desert sands north of the line. East of Charwas Jhil, and up to Delhi, the water-supply depends on wells averaging 136 feet in depth and 24 feet in diameter, and estimated to hold 40 feet of water,—a capacity of 97,000 gallons, relieving the road of dependence upon slow percolation.

PART OF THE LANDOWNE BRIDGE OVER THE INDUS AT SUKKUR.

(*E*) *Jumna plains section, 50 miles long* (700 feet above sea-level).

The plains of the river Jumna are now reached, and finally Delhi, nestling between the famous ridge and the glittering Jumna.

The country, now free from sand hills, is well cultivated, and abounds in fine trees and gardens. The line next Delhi skirts the north side of the large Nujagarh Jhil, or swamp, made famous by the decisive victory gained by the immortal Nicholson over the Sepoy army a month or so before the storming of Delhi in 1858.

Having thus reviewed this long stretch of country, attention is now drawn to the grades and alignment of the project.

Gradients. The ruling gradient is 0.66 per cent. (1 in 150), and is confined to the west end of the line over a length of 230 miles,

CHAPPAR RIFT BRIDGE, SIND-PESHIN RAILWAY.

of which 87 miles are $\frac{1}{150}$ grades; 52 miles being with the load or traffic, and only 35 miles against it. On the east side, for 306 miles, the maximum grade does not ascend 0.33 per cent. (1 in 300).

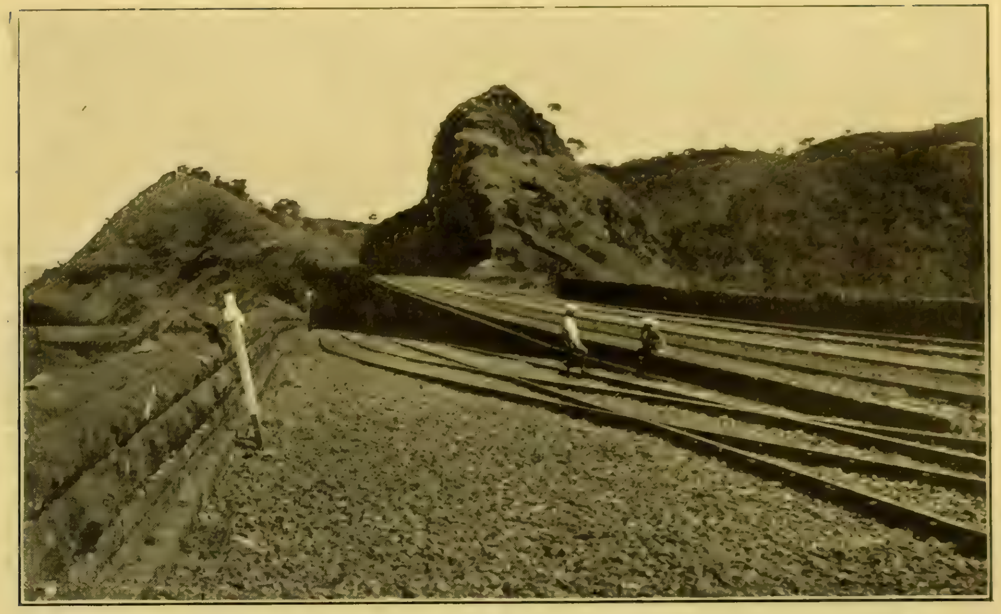
Ratio of gradients (above 1 in 2,000) to total length of line	66.82 per cent.
Average amount of rise per mile	6.27 feet.
Total length of grades $\frac{1}{300}$ to $\frac{1}{150}$, or 38.4 per cent. of length	211 miles.

Curves. Curves of three radii have been adopted, ¼°, ½° and 1° curves, except in three cases a 2° curve, near Delhi, to get round the ridge, and in the sand hills. Compensation is allowed on all curves on gradients against the load to Karachi.

Total length of curves	109.07 miles
Total curvature	3103°
Ratio of curve to length of line	19.8%
Average amount of curvature per mile	5.6°

A few words may now be given to the results of the survey, under the three heads of construction,—*viz.*, bridges and culverts, earth work, and water-supply.

Bridges and Culverts. These are only one hundred and fifty in number, of which ten are 40-span bridges and the remainder 2 to 20-feet, giving 3,118 lineal feet of waterway, or at the rate of 5.7 lineal feet



REVERSING STATION, BHORE GHAT INCLINE, G. I. RAILWAY.

spans, per mile, at an average cost of Rs. 177 (£11) per lineal foot of waterway. The only large bridge is over the kantli nala (four hundred and thirty-seventh mile) consisting of 36-40 spans,—in all, 1,200 feet long, costing £11 per lineal foot. It will be thus seen that the bridging amounts only to Rs. 1,000 (£631) per mile.

Earth work. This amounts to 686,000 feet per mile, or an average height of 4.8 feet of bank throughout. The difficult part of the construction is through the Sind desert for one hundred miles, where it will be necessary to protect the formation and the slopes from the fierce winds, called "Andi," prevailing from the south-west during May and June, when it is absolutely necessary to protect the slopes by sowing grass seeds or planting grasses and bushes. There are more than forty species of grasses alone, not including the hardy trees, named rohira, tamarisk, gumbat, rundiala, and gobal; also the candelabra cactus, and milk, or "ark," bush. It is proposed to divide the surface of the slopes into pockets by placing wattle walls at intervals of 10 or 15 feet apart, square, or perhaps obliquely to the centre line, depending upon the position of the railway with reference to the prevailing winds from the south-west. By this means the sweeping and scooping action of the wind would be broken up.

Several methods will suggest themselves to foresters* for consolidating the slopes, and the experience gained in the landes and dunes of Gascony and the Baltic coast of Germany will be of great use in fixing the few sand ridges which are bare. The neglect of precautions, and the result of depriving a country of its natural grasses, are illustrated on the Trans-Caspian Railway, where, from all accounts, long stretches of that railway have become nearly impassable. Moreover, the formation must be protected, for its full width, by a layer of ballast at least six inches in thickness, with which the rail level should be kept flush.

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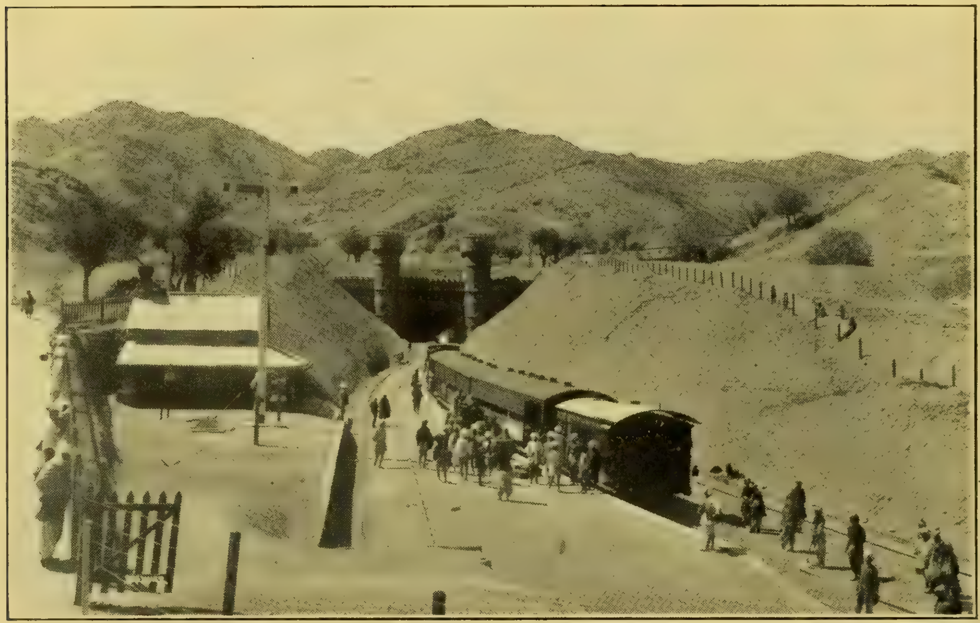
* An interesting account of the dunes of Gascony has been written by Lieut.-Colonel F. Bailey, in the *Indian Forester* for January, 1888. See also the notes on the fixing of the dunes, under "Elements of Sylviculture," by G. Bagnoris, inspector of forests at the Forest School of Nancy, published in 1882, as well as Mr. John Gifford's article on "The Control and Fixation of Shifting Sands" in this Magazine for January, 1898.


KHOJAK TUNNEL, SIND-PESHIN RAILWAY.

Water-Supply. The two large reservoirs have been already alluded to, but the following information may be added :

ESTIMATE FOR WATER-SUPPLY—PIPES, RESERVOIRS, AND STEAM PUMPS.

	Pipe line.	Rate. Rs.		Rs.
(a)	29,800 tons piping valves, etc., @	105	per ton	31.29,000
	297 miles of laying @	1,320	per mile	3.92,040
(b)	*Reservoirs* (major) C. feet	Rs.		
	No. 1. Charwas 29,403,000 @	39.115	per million	11.50,000
	No. 5. Karkana 55,000,000 @	39,115	per million	21.51,325
(c)	*Reservoirs* (minor)			
	Nos. 2, 3, 4, 6, 7, and 8, 1804 lineal feet @	100		1.80,400
(d)	*Steam pumps.*			
	16 sets to pump up power 60 to 240 feet high from Rs. 1,400 to 5,400			46,725
	Total expenditure for water-supply in desert sections			Rs. 70.49,490
	Equivalent at 1s/6d exchange to			£469,966
	Rate per mile			£1,637

The water-supply, which dictates the working capacity of the railway, is estimated for an average of 14 up and down goods trains, —that is to six trains down, equivalent to an export tonnage of 365 days × 6 trains × 400 tons = 876,000 tons.

It now remains only to conclude with a few remarks on the actual survey operations. The government of India could spare only one of its engineers (the writer) to take charge of the detailed survey. He gathered from all parts of India a temporary staff of engineers and surveyors, who set to work in December, 1889, or within five weeks from the date of sanction. The staff was divided into two parties,—the west and east,—consisting of one railway engineer of experience in charge of the party, with six assistants, or a total of fourteen surveyors.

In addition, a native doctor and fifty to sixty "klassis," or field men, were provided for each party. Special arrangements had to be made for the supply of rations and a water service to the west party in the Sind desert, and it was with the greatest difficulty that the camel men were prevented from deserting, owing to the bad accounts they had heard of the "dura" country. The rate of progress of the field work of the east party, which surveyed from Delhi westwards towards Karachi, a distance of 320 miles, in 98 days, was 3.26 miles per diem, including Sundays. The engineer reconnoitred ahead, and ran the traverse; two assistants were engaged on the longitudinal levels, at 250-feet intervals, in open country, and two native surveyors were engaged on plane table work on the base lines, which included the survey of the hills, villages, nalas, and village boundaries.

The west party (under the late M. Louis Michel, a well-known Scinde, Vangat & Delhi railway engineer), starting from Sufi on Nara river, near Umerkot, surveyed eastwards a distance of 225 miles in 90 days, or at the rate of 2½ miles a day.

This was very good work, considering the rough nature of the country through one hundred miles of sand ridges. The cross-sectioning of the narrow vallies and the digging of some two hundred trial pits also involved extra work.

The rapid completion of this survey was in every way satisfactory, as any delay in the progress would have brought the work into the month of April, when outdoor operations are impracticable, owing to the violent sand storms and hot blasts of wind, which often cause the death of natives. The success may be attributed to the competent and ample staff, and the experience gained in the reconnaissance of the previous year. The longitudinal levelling was particularly good, as, when the two parties met, the difference in the levels amounted to only 0.15 feet. It was the more satisfactory, as the success of the project depends on a pipe line for the water-supply for two-thirds of the distance,—a length of 360 miles. The office-work occupied the chief, with three engineers and two native assistants, excluding numerous tracers, three months, and comprised printed reports, estimates, appendices, and tabular forms, with five books of index plans and sections, detailed plans and sections 400 feet to the inch, cross-sections of one hundred miles of the sand-hill valleys, miscellaneous drawings, and pipe-line diagram. The complete survey thus occupied the staff but the short period of eight months, from the date of receiving the orders of the government to that of taking up the work.

The cost of the survey amounted to about 64,000 rupees (£4,000), excluding instruments supplied by the India survey department,—a rate of £7.10:0 per mile.

Note.—The estimated total expenditure for 551 miles of railway is Rs. 592.61,753, or a rate per mile, at 1s. 4d exchange, of £7,171. This amount provides for ample rolling-stock to meet a traffic of 2,400 tons daily, but excludes interest on capital during construction.

The illustrations of Jodhpur and Bikanir are from photographs by Shepherd and Bourne, Bombay; those of the G. I. R. and the Sind-Peshin and Mushkaf-Bolan lines (reaching territory northward from Delhi), as well those of the bridges, were photographed by Bremner, of Quetta.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

III.—EFFECTS OF ENVIRONMENT ON THE EFFICIENCY OF WORKMEN.

THE efficiency of the mechanic is, of course, largely affected by his environment, his social life, and his relations to his employer. A genius here and there may raise himself out of his surroundings, and prove himself superior to the accident of birth, but it is practically true of all men that their careers are determined by their environment. Consequently we look for the most efficient men in those countries where environment is most favourable to the development of the greatest number of intelligent and skilful workers. A comparison of the conditions under which mechanics live and work in Europe and in America will throw some light on the subject under consideration. Reference is especially made to the superior mechanic or engineer, and not particularly to the factory hand or ordinary worker outside of the machine shop.

To begin with, children born in the new world have decidedly better opportunties of acquiring a higher education, under more favourable conditions than exist in European countries. Schools of every grade, sometimes even including the universities, are free, and the child of the workman can have an education fitting him for college without a penny of cost to his parents, except what is necessary for clothing, food, and shelter. As a rule, books are supplied to all, free of charge. The subject-matter of education is much the same in all countries, but the important distinction between the school life of the workingman's child in Europe and in America is that the American child, from the beginning to the end, associates commonly with children of every social rank, is brought up side by side with the child of the employer, and has exactly the same educational opportunities and associations. This is not the case in European countries. What is known as the "board school" in England, and as the "gemeinde-schule" in Germany, does not exist in America. The public schools of America are board schools only in the sense that they are supported by the taxpayer; they differ from board schools in being patronized by all classes of society. Secondary schools, high class public schools, and schools for the "sons of gentlemen," in the English sense, are practically unknown in America. The effect is noteworthy, and, I think, beneficial. The children of the American mechanic and of his employer often maintain throughout life the social relations that prevail in the school, and in the majority of cases this equality lasts till they are fourteen or fifteen years of age, or leave school to work. These relations in childhood are apparently an effectual barrier to the development of those hampering social distinctions so well known and so sharply drawn in European countries. Class distinctions, although they exist, do not operate in America, as in Europe, to impede progress and development among the working classes. The youth of fifteen years may be the chum or comrade of his employer's son. Entering the shop as an apprentice, he has already, through childhood associations, developed ambitions, and is incited to become something better than an ordinary workman. He hopes to become in time an inventor or a proprietor. Such ambitions are crowned with success only in a few cases, but the general effect is the creation of ambitious workers, and a class of progressive, thinking mechanics. The fact that it is not so difficult to rise from the ranks in America as in Europe assists to develop a larger number ot good workmen. It is admitted by those who have had the opportunity of observing that it is easier to secure a number of skilled workmen with progessive ideas in America than in Europe. A glance at European conditions will bear out these statements. The average English, German, or French workingman's son, throughout his school life, his apprenticeship, and his work as a journeyman, does not, with but rare exceptions, associate with anyone outside his own class. He is born a workingman and branded a workingman, and seldom thinks of becoming anything else. Elevation to a higher class of living and associations is considered entirely beyond him. The effect of such a view of life is not calculated to produce the greatest number of skilled workers. Not only as a workman are the man's ideas limited, but in his social life he conceives no change or improvement. I am speaking of comparative conditions, leaving out of consideration the small number of workmen on either side of the Atlantic who have clear conceptions of the value of real democracy (which does not exist anywhere) as a means of improving industrial conditions and of securing greater happiness for all. It is a singular fact that, as a rule, European workmen, even to the lowest rank, cling to slavish social distinctions which do not exist among American mechanics. The European mechanic's position in the machine shop gives him a social rank which he is careful to protect, and a recognition which he exacts from all below him, in the same way that he in turn submits to those above.

This condition is not so aggravated in England as in Germany, where, as I am told by the manager of large works, workmen will actually accept less wages when offered a position which is supposed to carry with it certain social privileges, the most coveted of which seems to be that of forever after looking down on their former associates. This state of affairs does not, of course, permit free interchange of ideas and criticisms, which is necessary to progress and the production of good work. Caste and social distinction in the machine shop effectually prevent the co-operation desirable between all grades of workers. Free criticism from those beneath is not encouraged ; complaints, or even suggestions, to those above are not tolerated. The German draftsman is eminently superior to the criticism of those whom he considers beneath him, although in most cases he receives less pay than an ordinary piece-worker. From management to the common laborer, each must consider his social standing above all things, knowing no influence but that of power from those above, and continually seeking an opportunity of exercising his own authority on those below. Undoubtedly the democracy of American engineers, which really exists so far as mechanical matters are concerned (although I am sorry to say it does not in their politics), is of great advantage to them, and will continue to be so, as compared with conditions surrounding European engineers. In principle and in practice American workmen of all grades and positions know no reverence or respect, except for superior ability. They know of no rank which interferes with a free interchange of ideas between workman and manager. This freedom of intercourse allows a criticism, inspection, and control which keep all constantly on the alert to produce work that will bear the closest inspection, and designs that have the greatest number of desirable features.

Having had good opportunities for observing conditions on both sides of the Atlantic, I am convinced that it is possible for the American mechanic to live in social surroundings with more of the refinements of civilization and more domestic comforts than can be enjoyed by the European worker of the same rank. The cost of living, especially of food, has a direct bearing on the productiveness of labor. Mr. Edward Atkinson, in his extremely interesting work, "The Science of Nutrition," states : "As a matter of fact, we find that the rate of wages is highest, or, in other words, the effective earning or productive power of man is greatest, in the United States, where the supply of food is most abundant." American living, as well as American wages, is the cheapest in the world. The slipshod conclusion of most travellers is that, as hotel and restaurant prices are low in Europe, consequently general living must also be cheap. The cheapest living in the world is in the western States of America ; there the greatest amount of nutrition can be purchased with ten hours of labor ; next come the eastern States ; then England ; then France and Germany. European machine-shop employees certainly *do* live more cheaply than American; they must, as they receive less income and food is less abundant. I feel certain that a more extended scientific research will prove that the non-effectiveness of European labor, as compared with American, is largely due to an insufficient consumption of nitrogenous food, owing in turn to the inadequate purchasing power of the workers. I know from actual experience that food materials, such as are demanded by the machine-shop employee in America, are not cheaper in Europe than in America. This is also true of clothing; although some materials are cheaper in Europe, good workmanship is rarely seen in the every-day wearing apparel of either sex. In every respect household conveniences and fittings are superior in America, of better workmanship and cheaper than those in Europe. This is, of course, due to the higher efficiency of labor, and the more extensive use of labor-saving machinery, by which all articles of manufacture are produced. House rents compare favourably, although European houses, compared with American in equally desirable surroundings, have not as many conveniences. European taxes are an aggravation to all Americans who have had the pleasure of assisting to support foreign governments. Although the lower ranks of mechanical workers in Europe are not heavily taxed by direct assessment, of course the burden which labor must bear cannot be shifted. Mr. Edward Atkinson estimates that national taxes in the United States are equal to 2½ per cent. of each individual's product, while in Great Britain they are 5 per cent. to 6 per cent., Germany 8 per cent. to 10 per cent., and France 10 per cent. to 15 per cent.

The facts of cheap living, liberal education, freedom from class distinction, superior domestic comforts, and lower taxes may seem to have a remote influence on the price and quality of machine tools; nevertheless they are economic conditions which are points of advantage in favor of the American workman, and with them the European must reckon in the world's competition. They are factors which assist to produce better workmen, with whom Europeans cannot compete unless their workers receive such wages as will enable them to enjoy equal conditions, and to live in equally favourable surroundings. I have heard it remarked by more than one European proprietor—men who were thoroughly acquainted with modern methods—that they simply could not consider the adoption of many improvements which they knew to be right, for the sole reason that such changes conflicted with the customs and conventionalities they live in. Of course, continental Europe is always at a disadvantage in the commercial race on account of the military service exacted from all. From one to three of the best years of a worker's life must be spent in the army.

This service is exacted at an age when men are by nature best fitted to learn and to become skilful artizans. As Mr. Atkinson states, "the power of production of France and Germany is minus the nine hundred thousand men who are wasting their lives in camp and barrack." This state of affairs may be unavoidable under the present circumstances, but, at the same time, I do not believe Germany realizes what the curse of military service means to her commercial progress. Aside from the expense of supporting an immense army of non-producers during their military service, she has to reckon with the evil influence of military training, both in the office and in the shop. Senseless bureaucratic ideas, which have their origin in military organization, pervade all. The educational system, the workman's sense of duty, the manager's conception of discipline and organization,—all is military. "Obey orders and ask no questions" seems to be the dictum of the machine shop as of the army. This, of course, is wrong. Machine-shop employees must be trained to become thinking units, not mechanical puppets.

I would by no means depreciate the moral character of the European mechanic, but certainly his standard of living, the care which he gives to his personal appearance, and the general condition of the shops in which he works, contrast unfavorably with those which the American mechanic enjoys. Propitious surroundings have, of course, an immeasurable influence on the efficiency and progress of the workman, and it is interesting to contrast the conditions, as we find them in European and American shops, in this respect. Take washing facilities, for instance. No American shop is too mean to provide for its men in this manner. In many cases factories are fitted with washing-rooms, appliances by which each workman is supplied by a running stream of water, and separate lockers for clothing. The American mechanic, as a rule, has working garments in which he never appears on the street. He never leaves the factory without washing and making a complete change of clothing. There is a marked difference between the appearance of the men emerging from an American engineering establishment and that of those leaving the average European shop. In this respect the continental worker is in advance of the English mechanic. In many continental factories I have seen good washing appliances, which are always used by the men before leaving. In almost every respect the European proprietor pays far less attention to the surroundings and comforts of his work-people than does the American manufacturer. It is rather the exception to see a thoroughly heated, lighted, and ventilated European machine shop. High-grade work and fine mechanical production require the best of surroundings and the greatest comfort for the worker.

Particularly is this true in working metals, as it is impossible to work in badly-lighted, poorly-ventilated shops, with benumbed fingers and cold feet, and turn out a really first-class product.

In considering the various causes which go to produce good and bad workmen, I have avoided the question of technical training, of which we hear so much at present, for the reason that technical education is not available to the great number of workmen, and consequently has little to do with the matter under consideration. In the manual training schools, however, I am looking forward to important results; but, at present, they are of comparatively little importance to the majority of workers. I am sure that, in either European or American machine shops, a very small number of the workers have had the benefit of manual training, or of technical education. It is well known that men of purely technical training, without practical experience, are of little use to the mechanical engineer. It is no recommendation to the proprietor of an American machine shop simply to state from which college one is a graduate. I believe that the majority of the best mechanical engineers in America have no college education. College training should not unfit a man for practical machine-shop work, but, as at present carried out, it seems to be a fact that it does. As far as the American situation is concerned, a corrective dose of five or six years' work in the shop seems to be the only cure for the college graduate. With respect to the European technically-educated engineer, particularly the German product, it is still more difficult to make him realize the value and necessity of practical training for those who would design or superintend. It would be well for those of other nationalities, who are at present looking at the German technical schools with a jealous eye, to endeavour to ascertain if the results attained in that country are wholly desirable.

The ability of a mechanic is, of course, largely influenced by the apprenticeship under which he may have served. By the European method the apprentice is usually trained in one class of work,—that of turner, planer hand, fitter, or whatever line he may have selected to learn. The American apprentice usually has an all-round training, and is generally allowed to work in every department of the machine shop, and, in many cases, in the drawing room as well. This all-round training produces mechanics who, by reason of their experience, can adapt themselves to various classes of work. At the same time, they can work more intelligently in whatever branch they may finally adopt as a calling, for the reason that they have a knowledge of other classes of work, as well as their own. The economical manufacture of machine tools, as of other articles, calls for a division of labor, but is peculiar in calling also for special training in the various operations. The cheapness and accuracy with which one operation can be performed are, of course, largely dependent on the thoroughness of the preceding operation. An operator must be able to judge of the previous workmanship on a piece of mechanism in order to determine whether he receives it in a proper condition. And acquaintance with succeeding operations assists him to perform his own work properly. The American apprenticeship system fulfils these conditions, which are conspicuously wanting in the European. This is of unquestionable advantage to the American maker of machine tools, particularly as it produces a greater number of that valuable class of workers known as "tool makers," which, judged by the American standard, practically does not exist in Europe. It has been the uniform experience of American engineers with whom I have come in contact, who have had occasion to employ European workmen, that the European is totally at a loss if he has to tackle any problem for which he has not been trained, or that deviates to any extent from his routine work. The boasted superiority of thorough English workmanship is a myth. The thoroughness for which the German is phenomenal, in some respects, surely does not hold good as far as mechanical operatives are concerned. I have had considerable experience with all classes of European workmen,—carpenters, masons, foundrymen, machinists,—and I must say that there is a conspicuous lack of appreciation of good work among them, and that the use of primitive tools and methods is common. These deficiencies are largely due to bad supervision and want of intelligent management. Corresponding classes of workmen, under more favourable conditions and better management, form a large part of the best mechanics in America. It is a fact, verified by statistics and the statements of many American makers of machinery who have successfully introduced their machines into European countries, that, under European conditions and when handled by European workmen, American labor-saving and automatic machinery turns out from 30 to 50 per cent. less than is produced by the same machinery in America. I am told that the royalties on the McKay boot-stitching machines, paid on the products turned out, are one-third less from the machines in operation in European countries than from those in operation in America. I know that, on certain machines for the production of bicycle parts, operations which are regularly performed in America in from six to seven minutes usually take from ten to twelve minutes in the hands of European operatives. This is due chiefly to inefficient labor and the want of properly-trained tool makers to keep the machines in a high state of efficiency. It is also stated that the product of the Singer works at Glasgow is no greater than that of the works in

America, although they employ one thousand more operatives. The German is not as thorough a workman, taken all round, as the Englishman, although he has qualifications which, in combination with the adoption of new methods, are fast putting him to the front. He works harder and longer, and is more receptive of new ideas. German technical education, which at present seems so formidable to the Englishman, should really create no apprehension on the part of a competing nation, particularly so far as any influence it may have on the machine-tool business. It serves to carry the student so far into the consideration of the theoretical that, as a designer, he is apt to ignore practical results. This fact does not, of course, condemn technical education, but rather the way in which it is carried out. The most glaring faults of technically-educated men seem to be their utter ignorance of, and way of ignoring, the working details necessary to execute their designs. They make the most elaborate and exhaustive calculations, working out the most intricate problems in the most minute details, and make drawings that are monuments of painstaking care and works of art to look at. The consummation of the reality is accomplished in another world, to which they are strangers and with which they have no intercourse. Work should be supervised by those who have a knowledge of the end desired and of the results to be accomplished. As a rule, the German technically-educated man does not seem to have the spirit of practical investigation which is necessary to the best results. When he has made his fine drawings and elaborate designs, his work is done. The rest is left to poorly-paid labor, which, naturally, has little interest in the successful issue, and no comprehension of the end in view. This is in marked contrast to American methods, where control and inspection of workmanship on the part of designers is considered of as much importance as the design itself. Of course, this method develops more efficient workmen on the one hand, and more practical designers on the other. The workman has the benefit of coming in contact with the supervising skill and advice of highly-trained minds. The technical man comes in contact with the reality of form and operations, which cannot be learned from the "books." In European countries the influence of social conditions and military training maintains this isolation of workers, which the introduction of labor-saving machinery alone will not break down, and, for a long time to come, this will work to their disadvantage in competition with America.

In addition to the ordinary influences of social customs and shop training, the English mechanic's ability is largely controlled by the trade union. The recent engineering strike has so thoroughly disclosed the evils of trade-union tyranny, and has so clearly shown that many of the defects and inefficiencies of the British workman are alone due to its influence, that but little comment is necessary. Trade unionism, as it exists in England, is but the concomitant of class distinction, in the same way that Socialism in Germany is the concomitant of militarism. It is a weapon of defence of one class against the oppression of another. Although England leads the world in political freedom, the support which she gives to trade unionism is evidence of social rot. The work of the trade union should be to eradicate this rot, not to fight industrial progress. It should not try to restrict the number of machines one man can attend, to limit the number of apprentices, to fix the rate of wages, to restrict one man's output, and to determine the hours of labor. It should seek rather to bring about those conditions of social and economic freedom under which an individual can work as long as he likes, attend as many machines as possible, produce his utmost, and receive the full reward of his efforts. Trade unionism in England is on the wrong scent. The British workman is his own worst enemy. It would not be true to say that the American mechanic has a better understanding of economic problems than his British brother,—the fact is, I believe, that he has not as good,—but he is surely at present working under certain conditions of freedom that are of immense advantage to him in competition with other nationalities. I am not acquainted with one American machine-shop employee whose work or progress is influenced by any organization or society. I cannot call to mind an instance of a first-class American mechanic who is a member of a union. The development of individual talent requires freedom from rules and restrictive influences. This state is more nearly approached in America than in Europe. It is obvious with whom the advantage lies, as the following instance will show. A large American manufacturer is sending large quantities of a superior article to England. That shipments may be made in a more compact form, he has established works in England for putting together parts machined in America. On a recent visit to the English factory, he observed the manner in which the work was done. Calling the foreman to one side, he told him that he could show the workmen how they could, with the same effort and working the same number of hours, earn from 25 to 30 per cent. more in wages, and asked if it would not be advisable to do so. The foreman thought it was a good idea, and spoke to the men. On calling next day, much to the surprise of the American, not a man was at work, and it was three days before work was resumed, and then only on the condition that no innovations would be attempted. It is also of interest to note that the wages cost of the work turned out of the above factory is more than double the wages-cost of the same product in America, though the American workman receives 50 per cent. more than the Englishman. Trade unions in England are certainly doing good work in their efforts to abolish half-time child labor, to reform the conditions surrounding woman labor, and to solve the land question, but they show little understanding of commercial conditions or of modern manufacturing requirements.

I can hardly believe that manufacturers and workmen realize the time they lose by the peculiar division of the hours of labor which prevails in many European workshops. Work is begun at six in the morning. Rising at an early hour, there is perhaps little inclination to start with a substantial meal, on account of limited time. To get a full head of steam with a scanty amount of fuel is difficult. Work continues for two hours; then half an hour is taken for breakfast; then work starts again, and is kept up for three hours; then a stop for dinner, after which work is resumed. In England tea is allowed in many shops in the middle of the afternoon, and nearly always in the offices. The continental worker is usually allowed to eat twice during working hours,—in the middle of the morning and the afternoon; beer is also allowed during working hours. Taken all round, the European worker is at a disadvantage compared with the American, as so much time is consumed in stopping and starting, in eating sandwiches, and in drinking beer and tea during working hours. It is impossible to produce as much work in the ten hours in this dawdling, nibbling fashion as can be turned out in straight-away runs, under full steam, with good fuel and plenty of it. Estimate the time wasted in one day for the breakfast-hour alone, in an English workshop where one thousand men are employed. Is it an exaggeration to say that ten minutes are lost at this time by each individual? For one thousand men this is, say, 160 hours per day; in a week, 960 hours. At 6d. per hour, it amounts to £24. Messrs. Smith & Coventry, of Manchester, have recently adopted the American practice, doing away with the breakfast hour, and they find the change satisfactory. The American mechanic begins the day with a substantial breakfast, starts work at 7, works without stopping till 12, has an hour for dinner, and works again from 1 to 6 without stopping. No beer, no tea, no sandwiches. Well-fed, steady working. Which has the advantage?

The net results of environment, education, social life, and habits are certainly in favor of the American mechanic. The American conditions produce more active workers, unhampered by the traditions, customs, and conventionalities which exist in older countries. Individuals have a more serious interest in their work, and there exists a desire to improve on the part of the lower-grade workers, side by side with the finer and more highly productive mechanic. The American mechanic has little interest or inclination to make his work "hold out." He knows that his wages and promotion are dependent on producing the greatest quantity in a given time. European mechanics, on the other hand, are hampered by established customs and class prejudices. One's lot is accepted as a decree of fate which cannot be altered. There seems to be a tacit understanding on all sides that the exploitation of labor is a matter of course. The consequence is that workmen have little interest in improving, or in becoming more highly productive, and feel that reward for special effort simply enriches their employer, while their own condition remains unchanged. Employers, expecting no extra exertions on the part of workmen, mainly direct their efforts to keeping the wages account as low as possible. What can European manufacturers do to compete with superior conditions which exist in America? A complete social revolution is out of the question, or too remote to be of practical consideration. I know, however, that successful efforts are being made by several large concerns to improve the conditions surrounding their workmen. They must exert themselves to create such conditions in their works that the objectionable ideas which tend to defeat the end in view—*i. e.*, the development of the greatest number of intelligent workers,—cannot thrive. As a first step towards raising the standard of work, I know several European companies which are engaging American managers, foremen, and workmen. Where works are large enough, great improvement can be made through better organization, a good system of apprenticeship, well-arranged shops, and high wages, in spite of discouraging outside influences. An independent standard can be established which will characterize such establishments, and give them such a name that only the most desirable elements will be found within their walls, or will seek to enter. Europeans have other problems to solve, aside from that of becoming good copyists of American designs. Economic conditions, as well as factory organization and new methods, must be studied by both employers and workmen. On the other hand, Americans should realize that time is liable to fetter them with the institutions that hamper industrial progress in Europe; they are already founded, some of them are flourishing, and political conceit and ignorance are nursing their growth. Unlimited resources, highly-developed machinery, and efficient labor will not alone prevail. Although few admit it, the coming problems for Americans are political, not industrial.

THE DEVELOPMENT OF WOOD-WORKING MACHINERY.

By John Richards.

IN wood-working processes the first in order is the conversion of logs or balks into merchantable sections, called planks, boards, scantlings, or deals, by what are called saw mills. Unlike the other operations of wood-converting, which are effected on both sides of the Atlantic by machines directed to the same purposes, log-sawing presents a distinction so great that it is expedient to consider American and European practice separately.

Machinery for log-sawing has been extensively changed in the United States during the past thirty years, having been more than doubled in capacity and gradually directed toward greater economy and an avoidance of the waste that formerly shocked the people of other countries.

At the Centennial Exhibition of 1876, I accompanied some Russian officers to see an American circular saw mill in operation there, feeding at some forgotten rate, cutting out a kerf of about three-eighths of an inch and producing surfaces that can be imagined. It was considered admirable, according to American ideas of sawing timber, because of the "speed." The Russians, with some other foreign engineers in the party, gazed in wonder at the performance, and, after a short time, the chief officer exclaimed: "Horrible!" whereupon they all turned away and left the place. Several years later the subject was discussed with this same officer, who said the waste of timber and the rough character of the work seemed to him "barbarous." This circumstance led to a tolerably complete examination of timber-sawing and of the causes of so wide a divergence in methods between the United States and other countries.

Inventions and changes in this class of machinery in the United States, where they have been more numerous than anywhere else, have been the result of two causes: one, the custom of sawing timber to merchantable dimensions when green, in forest mills,—a "single reduction," so to call it; the other, an effort to attain speed of performance, instead of economy of material and good work. These things are sequences of certain local conditions peculiar to North America generally.

Timber is cheap, plenty, and of a wonderfully fine quality. Labor, machinery, and capital are dear. Waste in sawing, by reason of wide kerfs and irregular dimensions, is not much considered. Some idea of the difference between the United States and Europe in the matter of cost of forest timber can be gained from the fact that formerly there was a large trade in balks of walnut and poplar or tulip wood, felled and squared in Indiana, transported by rail to New York, sent across the Atlantic, and again transported by railway to European cities, to be finally sawn into dimensions for use. Such timber is sawn into one-inch boards with a loss not to exceed a twelfth, while, if the same timber had been sawn where it was felled, one-third—or more, if circular saws were used—would have gone into sawdust. Not all the waste, however, was due to this symtem of forest or green sawing; warping, breakage by handling, dam-

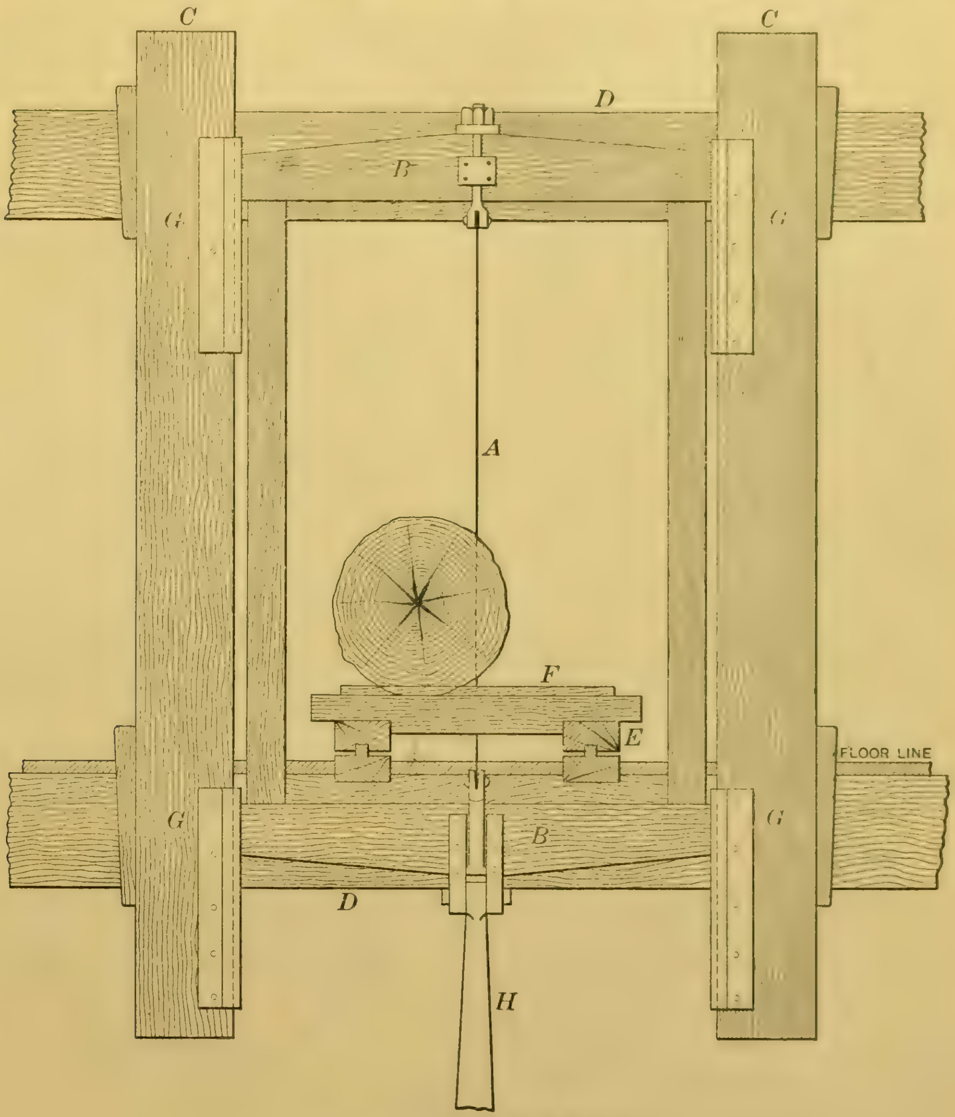


FIG. I. SASH SAW MILL.

age by grit and stains incident to seasoning, and loss from irregularity of dimensions, amount to more than twenty per cent. of the original cubic contents.

This single-reduction system extends even beyond the sawing of logs to finished dimensions. In some cases on the Pacific coast, for example, flooring, ceiling, weather-boards, and the like are planed green, from the log saws, and are so supplied to the merchant-consumer. There have been, no doubt, economic conditions of a local nature that rendered these wasteful methods expedient, but such conditions no longer exist, and the present tendency, as will be shown, is to greater economy.

Sawing to dimensions in forest saw mills continues yet, mainly by reason of custom. The timber dealers require immense yards, in which are stored timber of all dimensions, piled up as it comes from the mills. Few of these dealers have machinery to cut out orders to accurate dimensions, as is the custom in European yards, where the stock usually consists of three kinds, or units,—logs, balks, and deals,—from which orders are prepared as wanted.

With this brief explanation of the conditions that have attended upon the evolution of modern log sawing machinery in the United States, and without which explanation it would in various respects contrast unfavorably with European practice, I will proceed to notice the mills* themselves, beginning with the old single sash saw—the primitive form employed all over the world, and yet to be seen in many places on both sides of the Atlantic, where a small amount of sawing is done to supply a local demand. As there are no available illustrations of sash saw mills at this day, an explanatory diagram, Fig. 1, is shown here.

A is the saw; B, the sash or frame

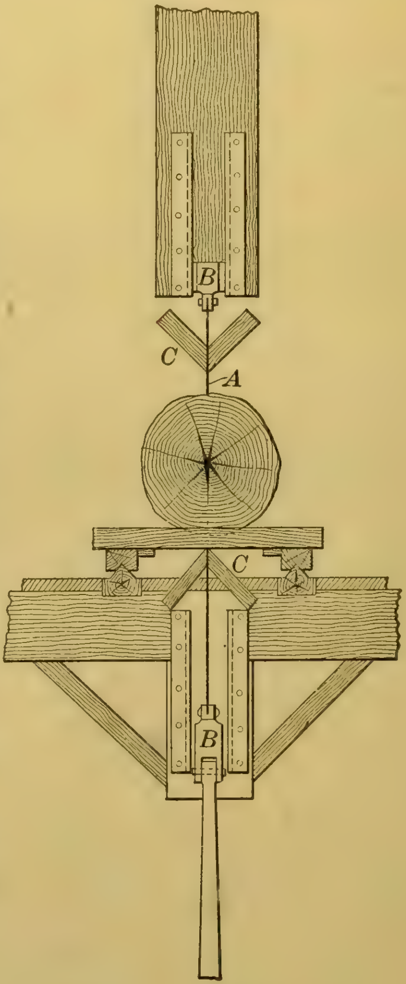


FIG. 2. A "MULEY" SAW.

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* The name "mill," which comes from the association of timber-sawing with grinding mills, seems irrelevant when applied to a machine, but is no more so than the term "frame" employed in England; besides, it has some warrant in the fact that sawing-machinery was formerly, and is yet to some extent, built in with mill buildings, constituting a portion of them.

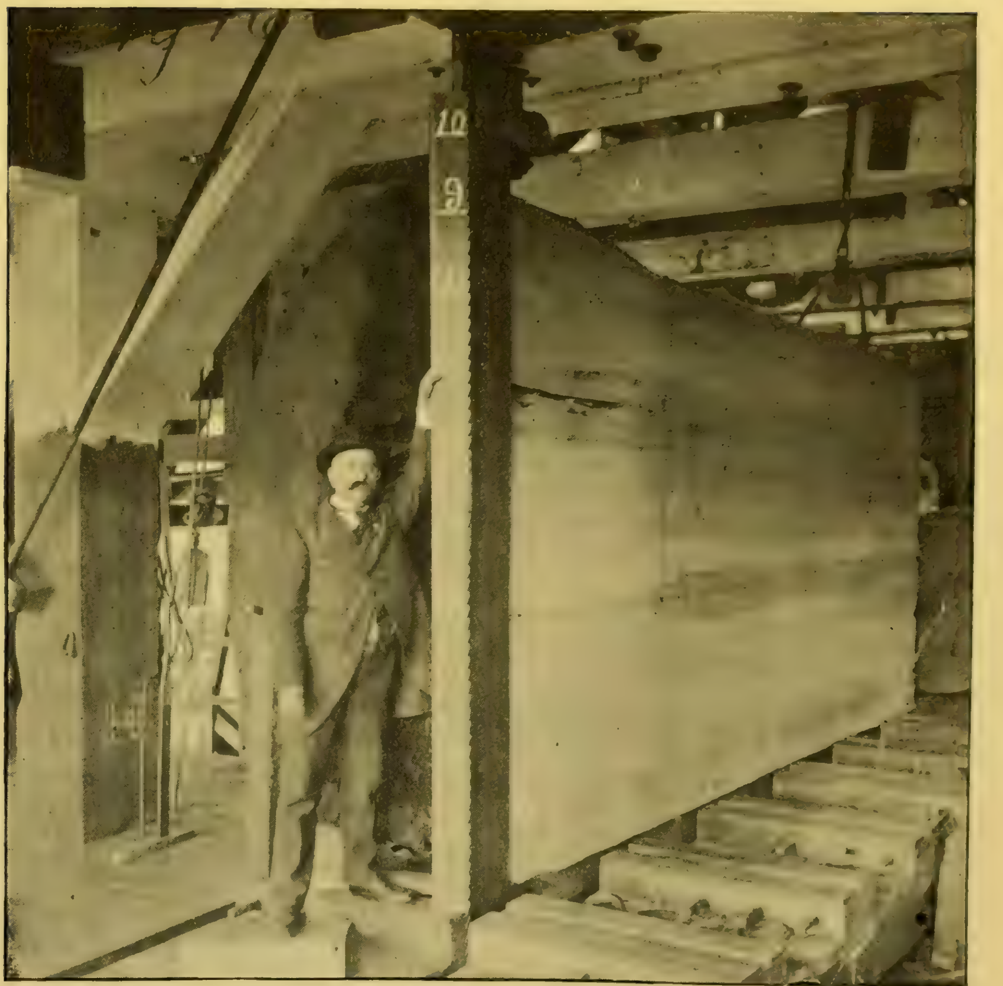

FIG. 3. EXAMPLE OF DEEP SAWING.

Showing cut, 9 ft., 6 in., deep, made with an E. P. Allis band-saw mill at Eureka. California; a fair average example of the heavy balks which can be cut only by the band-saw mill. Before the introduction of band-saws there was great waste of valuable red-wood lumber on the Pacific Coast, the logs often requiring to be split by charges of blasting-powder before they could be handled by the circular saws.

in which the saw is strained; C, C, fender posts; D, D, fender beams; E, the carriage; F, the head block. The whole structure, except the guides, G, and the forged "saw irons," is made of wood. The connecting rod, H, extends to a crank, commonly on one end of an engine or water-wheel shaft. The number of strokes is about 150 per minute, which makes a cutting movement of 300 to 400 in the same time, and the capacity is about 2,000 feet, board measure, in ten hours.

The first departure from the frame or sash saw system occurred in the Middle States about 1848, when "muley" saws were introduced. It was a bold innovation, having for its objects a reduction of weight

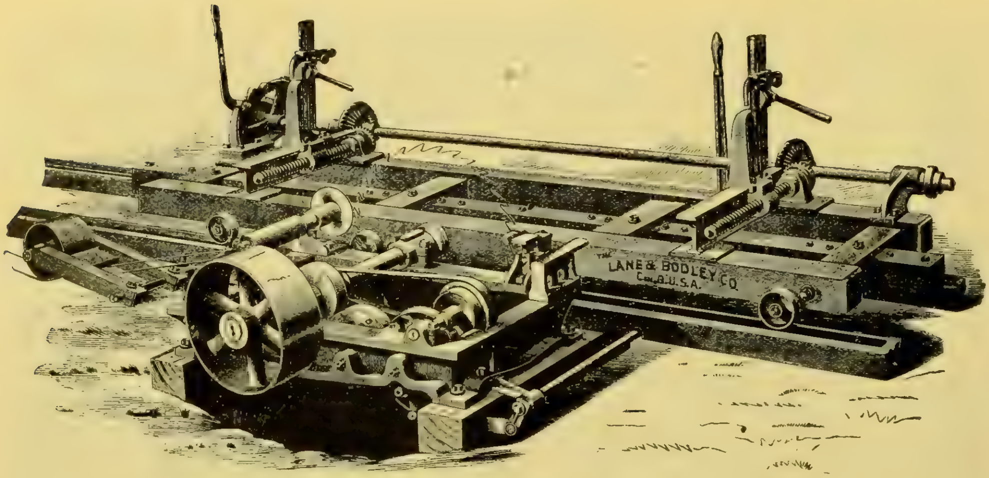

FIG. 4. AMERICAN PORTABLE CIRCULAR-SAW MILL.
Arranged for single circular saw, and showing feed works, and carriage with fractional head blocks.

in the reciprocating parts and an increase of speed. The speed was more than doubled. The method is illustrated in Fig. 2, where A is the saw, unstrained, and supported at each end by light cross heads, B, B, by the guides C, C, above and below the log, and by the log itself after the saw enters the wood. Other parts correspond to the sash or frame saw mills.

The speed was from 350 to 400 double strokes per minute, or from 700 to 800 feet of cutting movement. It was a bold scheme,

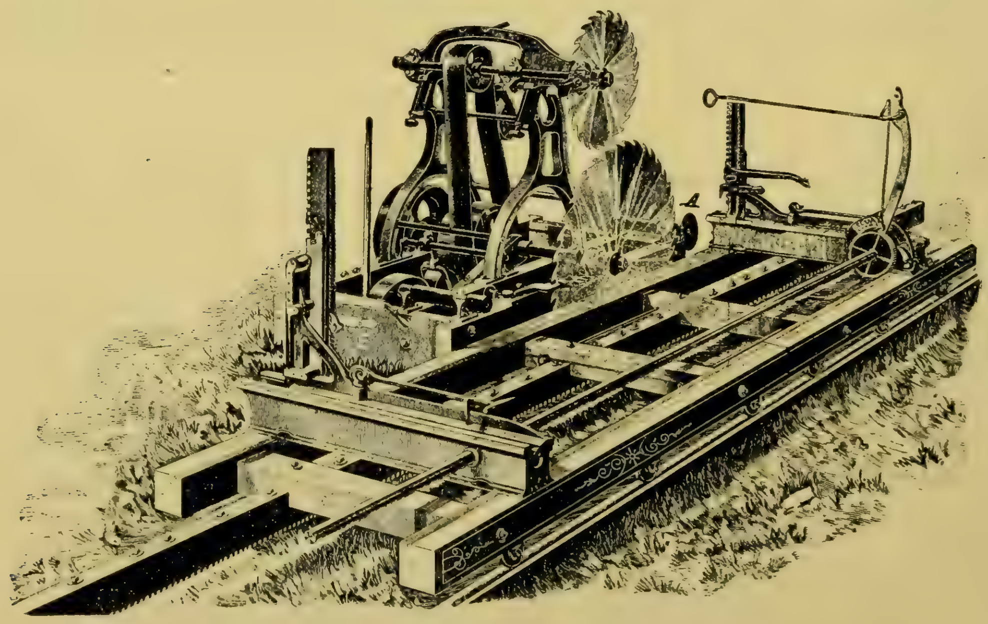

FIG. 5. PORTABLE DOUBLE CIRCULAR-SAW MILL.
Arranged with top saw, for deeper cutting than is possible with a single circular saw.

peculiarly American in its conception, but it soon disappeared when circular saws came in with a continuous cutting motion of 6,000 to 9,000 feet per minute.

An extraordinary feature in the "muley" sawing system was that in some cases the mills were single-geared to steam engines running from 350 to 400 revolutions per minute, and were the first examples in actual practice of such a speed of rotation. Later engines were directly connected to the spindles of circular saws running at a speed of 500 to 600 revolutions per minute.

This unstrained method of operating reciprocating saws lasted only a few years, and then began to decline—not to end altogether, however; it came in again about twenty years later, in connection with scroll saws, as will be noticed hereafter, and was again defeated by the substitution of continuous-acting band saws. In this connection it may be mentioned that the capacity of saws is a function of the rate of the cutting movement of their teeth. There are other limitations of a mechanical and operative nature, especially in respect to endurance and the effect of reciprocal motion, but the rule holds in a general way; in fact, it is obvious, if we assume a constant duty of the teeth. At first thought it will seem that there could scarcely be comparison between reciprocating and continuous acting saws in respect to the speed of the teeth, but this is not the case. Strained gang-

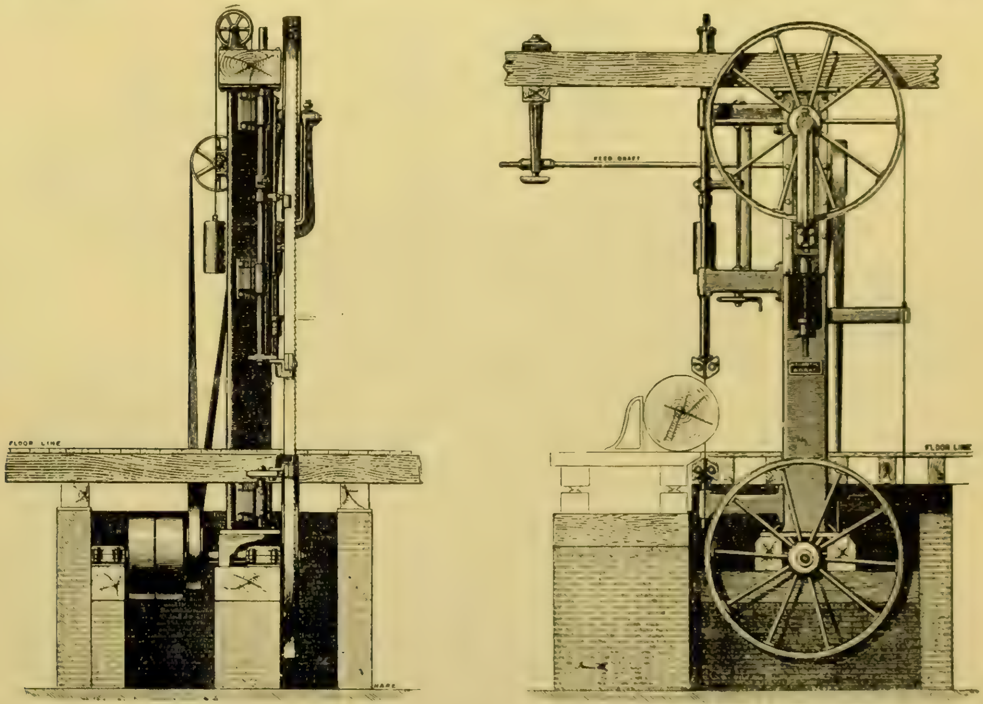

FIG. 6. EARLY BAND LOG MILL.
Built at the Atlantic Works, Philadelphia, 1872.

saws are capable of performing more and better work because of their rigidity, and a cutting movement of 4,000 feet per minute can be attained by a gang of saws cutting eight to twelve kerfs at a time.

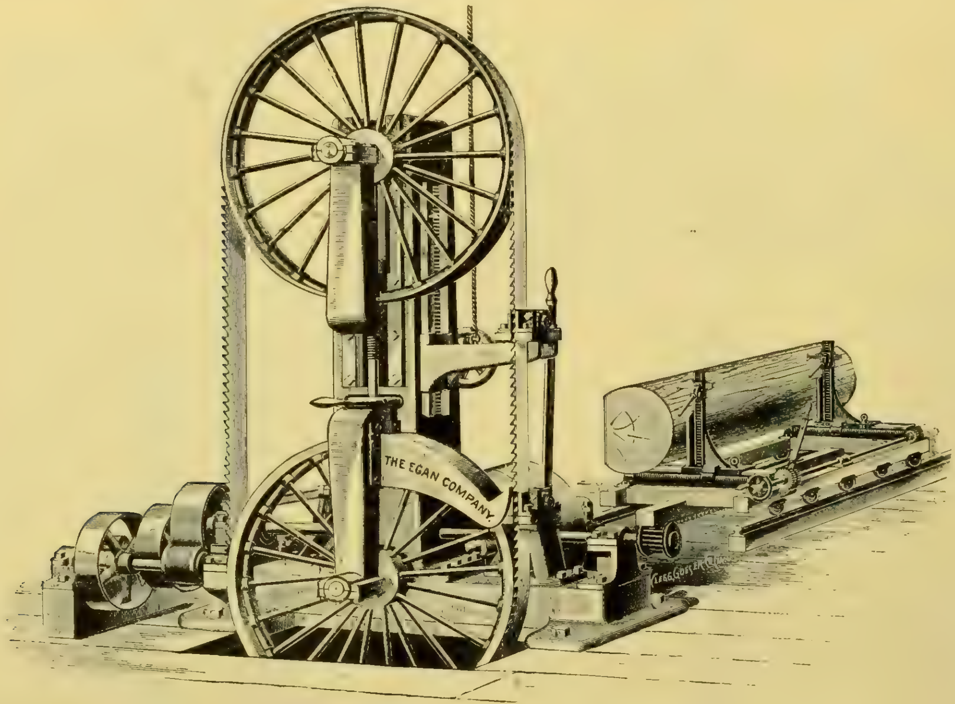

FIG. 7. AMERICAN BAND-SAW MILL.
Showing arrangement of carriage and feed driving gear.

Following and displacing the muley saws came the circular-saw era that has lasted to the present time, but is now being succeeded by band saws. They supplied a supposed necessity for greater speed of cutting, but the performance is, as the Russian officer described it, "barbarous," if we consider the kerf-waste, rough surfaces, and inaccuracy of dimensions. They supplied a want, and suited the peculiar circumstances that exist in America. Such machines are cheap, rapid in performance, and portable ; they can be erected in a few hours, and for this reason can be moved from place to place as the timber is cut away.

These conditions are peculiar to circular saws, and account for their wide use in common custom sawing. In addition to this, they are suited to some kinds of work, such as sawing taper pieces for telegraph supports, short pieces of any kind, and slabbing or squaring logs. Their principal features, however, are portability and cheapness, and this has caused the American circular saw mills to spread widely over the world, especially to southern parts.

Circular saws have certain inherent limitations. Their rigidity diminishes with their diameter and the dimensions of the work they have to do,—just the reverse of the requirements. They are unstrained,—"loose" is the usual term,—depending for lateral support on the stiffness of the plate, aided to some extent by centrifugal tension at high speed. For this reason the thickness of the saws has to be increased with their diameter, which has a limit of about seventy-two inches.

Deducting the saw collars from half the diameter, and allowing for some clearance at the top leaves, a cutting depth of thirty inches or less is left for a saw six feet in diameter,—practically twenty-four inches, which for American timber is far below the requirements. This led to a use of a second, or top, saw to act in the same kerf and in alignment with the main saw,—a device that made still rougher surfaces, but answered the purpose; it is a common type in the United States.

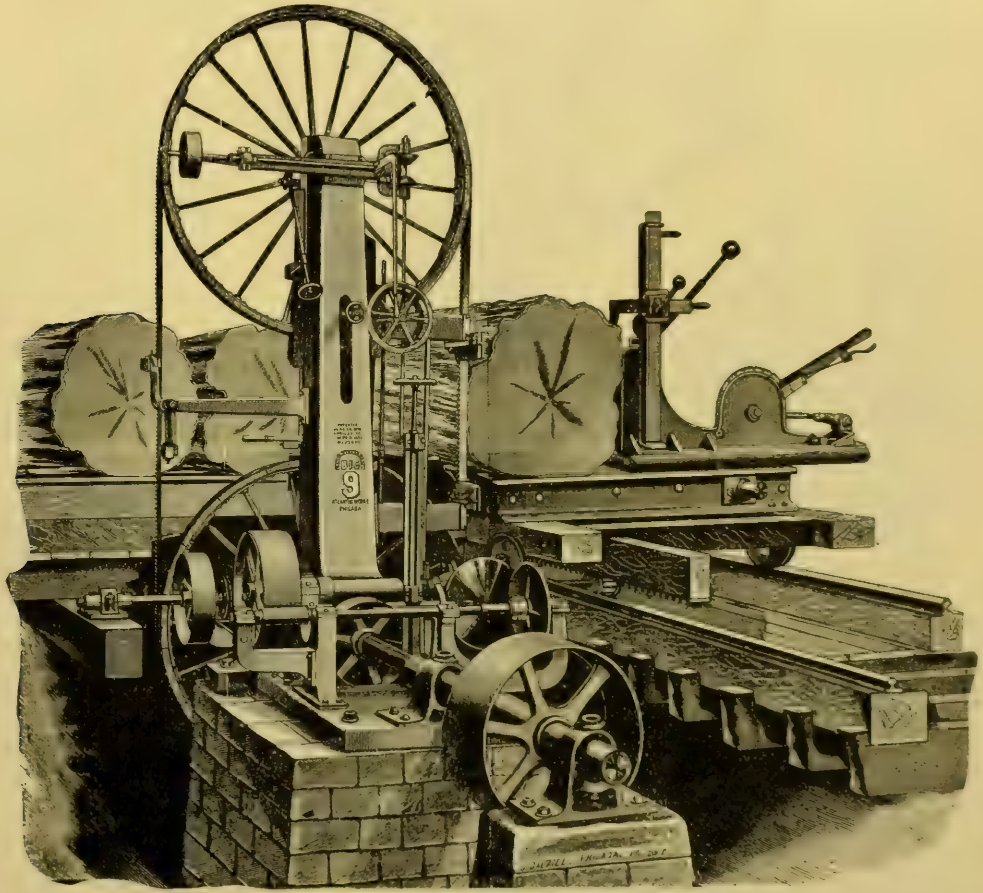
FIG. 8. AMERICAN BAND-SAW MILL.
Showing general arrangement for heavy log sawing.

The kerf waste in this system of sawing is enormous. Some measurements made at Portland, Oregon, some years ago, showed kerfs of 0.36 to 0.40 inches, amounting to a loss of 15 to 20 per cent. of the timber in excess of what would have been lost in sawing with band or gang saws. This is probably unusual, but in some tables at hand, compiled by a reliable firm, the difference of waste between band and circular-sawing of one-inch boards is set down at 21 per cent.

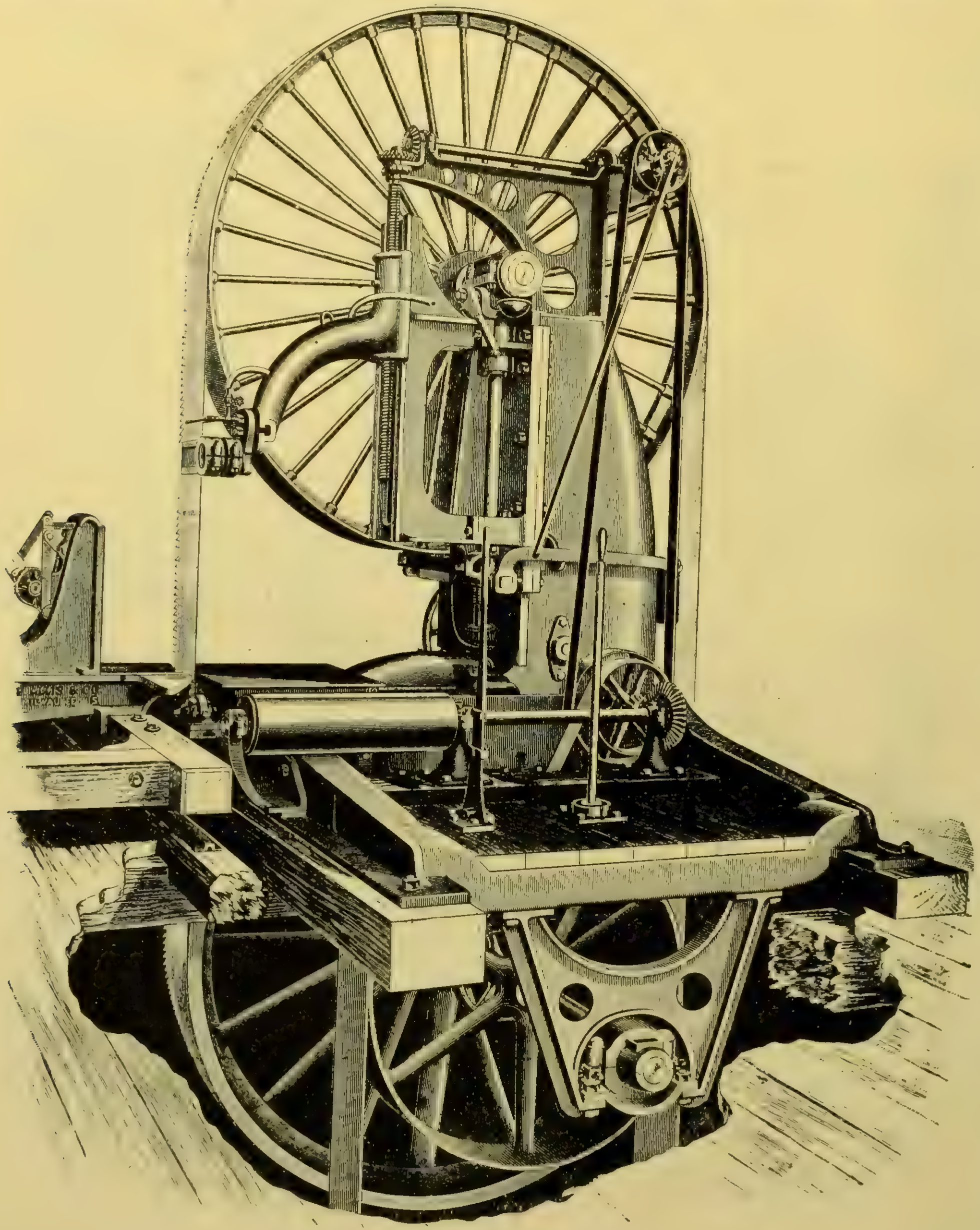

FIG. 9. AMERICAN BAND-SAW MILL.
For heavy log sawing, with a minimum kerf.

A good deal of the waste with circular saws in all kinds of sawing comes from the want of proper lateral support for the saw plates,—a matter that seems to be almost wholly neglected in American practice. This will be further explained hereafter.

Band saws for logs on heavy sawing, now in course of vigorous evolution in the United States, furnish a fair example of the tedious course of development through which even the most simple implements and processes must pass before settling down into successful use. All such things have to be tentatively learned through years of experience and by a consensus of knowledge and effort.

There are many who can remember difficulties encountered at first in the operation of circular saws for log-sawing; it was sometimes questioned whether such saws could be operated without deviation from their course. After a time there began to appear sawyers who could manage the matter. They received high wages, and their occupation was a mystery; but this soon passed away when it was discovered that the saws should not be guided from their centers or by the spindle, but by guides near the teeth at the front.

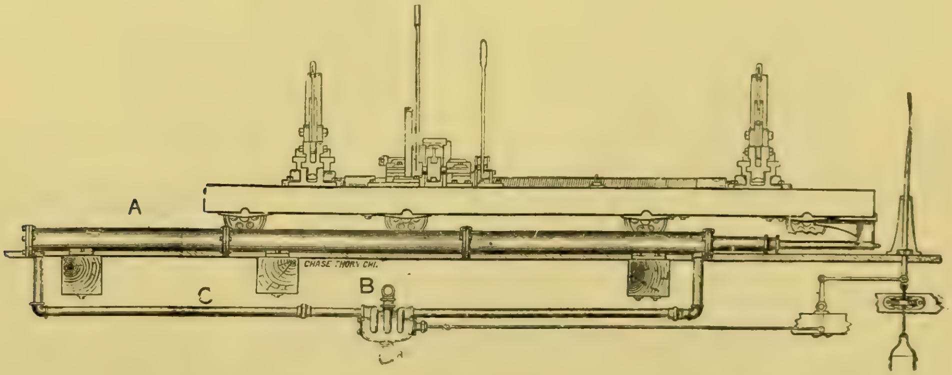

FIG. 10. DIRECT STEAM FEED FOR SAW-MILL CARRIAGES.
Used in connection with band- and circular-saw mills.

The same difficulties, but in a greater degree, came up in band saws for logs. The teeth at first were made short and close together, because the saws were thin and the gullets or spaces between the teeth could not contain the sawdust. Setting was done by bending the teeth, which was not at all a practicable way, and no progress to speak of was made for a long time. Fracture was a common result.

In the multifarious uses of steel there is perhaps no case where it is taxed as severely as in band saws. A log saw has a section representing about a half a square inch, which has to withstand a tension of 1,000 to 3,000 pounds, and bend through a curve of 180 degrees from 600 to 1,000 times in a minute, and which must have qualities and temper to maintain cutting edges; and withal it must undergo a continued change of temperature. The wonder is that any kind of material and care can maintain such an implement.

Band saw machines were definitely invented ninety years ago, and put into a practical form, as the illustration will show; but the discovery was of no use without serviceable saws, which could not be produced at that time, or for long after,—thirty years or more, when M. Perin of Paris succeeded in producing saws and machines that, at the first Paris Exhibition, won for him a principal award by the French government. He went on increasing the size of the machines and saws, until about 1868, when log-sawing was attempted with some success, but not in a manner to meet American requirements, except for special kinds of work. The saws were operated under high tension, and the cutting rate was so slow that the sawdust was reduced to a fine powder.

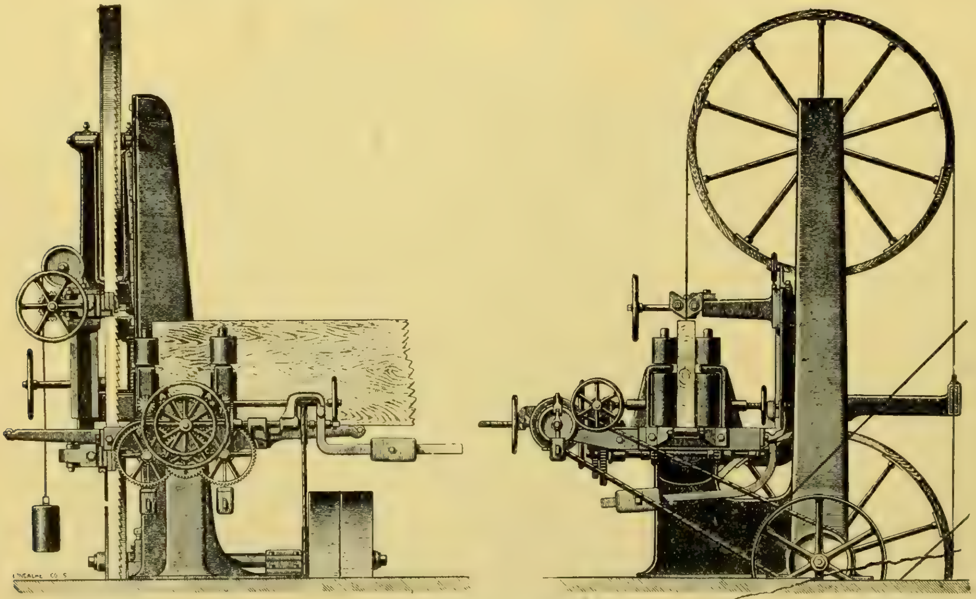

FIG. II. AMERICAN BAND RESAWING MACHINE.

In 1869 two of M. Perin's band saws were brought to New York, erected at the foot of Tenth street on the East river, and applied to cutting fine timber of large size—balks of walnut and tulip wood that were sawn into wide boards for piano-tops and other like uses. The boards were cut smoothly and accurately, but at a slow rate; for valuable timber of this kind the speed did not matter much, but the machines are incapable of common sawing at a commercial rate.

In 1870 the writer's firm at Philadelphia contracted with Mr. George Law, the celebrated engineer who built the Panama Railway and the High Bridge at Harlem, New York, to construct a band sawing machine to receive saws 48 feet long and 6 inches wide. The main object of the machine was to saw dock planking,—logs sixty feet long in some cases,—following the shape or curves of the timber.

Other machines soon followed, two of them for the Central Pacific Railway Company; they were made in 1872, and are yet in use,—one of them at Sacramento, Cal.

These machines were not as large as the first one at New York, but were self-contained, made of iron, and, in all essential features, as complete as any that have succeeded. They are illustrated among the drawings.

From this point on there was steady progress in band sawing logs, both in the United States and in Europe, especially in adapting the saws to rough work, which has been done mainly by American sawyers. The use of water on the saws has proved of much advantage. It keeps the saws cool and prevents changes of temperature, also tending to wash out the saw-dust.

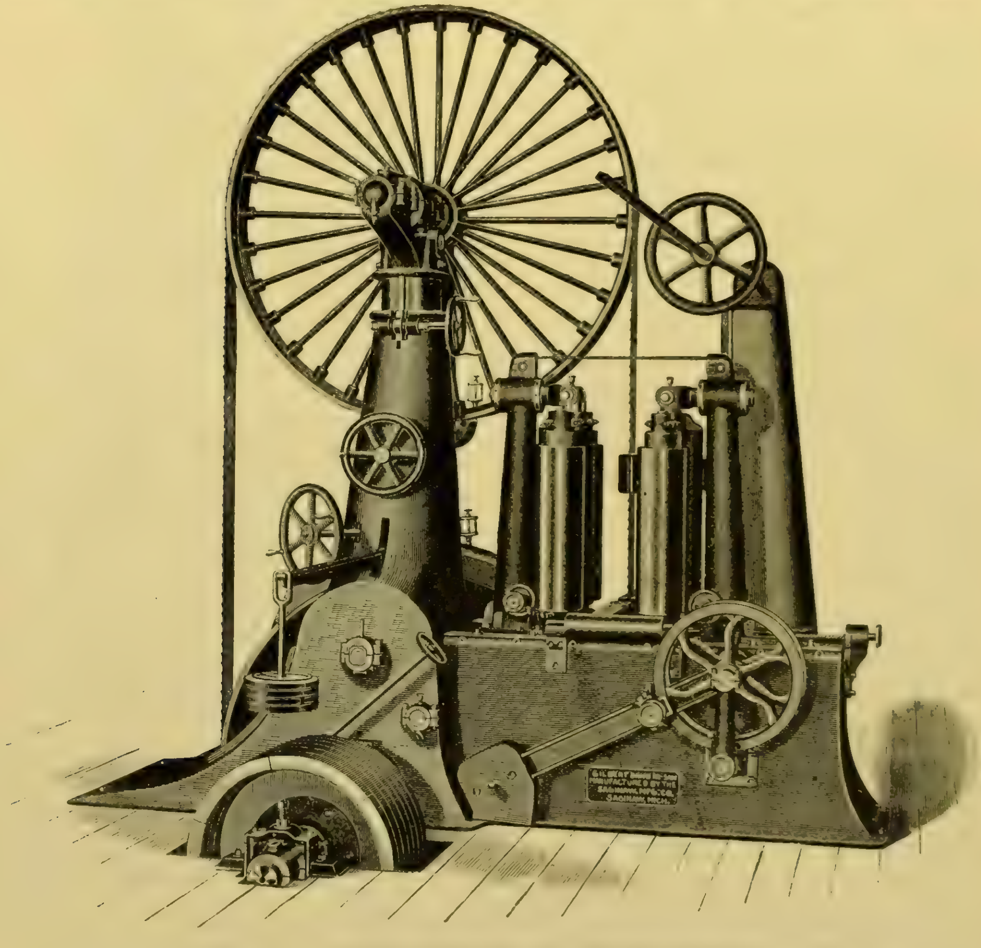

FIG. 12. AMERICAN BAND RESAWING MACHINE.
The timber is fed between the vertical feed rolls, and resawn to exact dimensions.

It would be tedious to go over the various details that have arisen in the development of band sawing. Some of the most important are as follows: improvement in the quality and temper of the saws; the alignment of the wheels by adjusting their shafts in a horizontal instead of a vertical plane, and thus avoiding flexure of the saws edgewise; change of the form of the teeth, and better sharpening, preventing back thrust on the saws; setting the saws by swaging, instead of bending the teeth; reducing the weight and momentum of the top wheels, so as not to slacken the saws when they enter the wood; use of water on the saws to maintain uniform temperature, and assist the escape of the sawdust; and, above all, the skill born of habit, empirical knowledge of what is required in order to succeed.

A successful band sawyer can not instruct others how to do his work, or put the matter in words at all, but he can keep his saw going, and avoid accidents to the saw and machinery.

In respect to design and construction there has been among American makers a strange recurrence to the original French idea of framing—consisting of a kind of bench for the top wheel and its accessories, which construction has some advantages to offset an ungainly design. The main object is, no doubt, to save metal in the frames, and to enable them to be made in pieces and bolted together. The illustrations show what is meant.

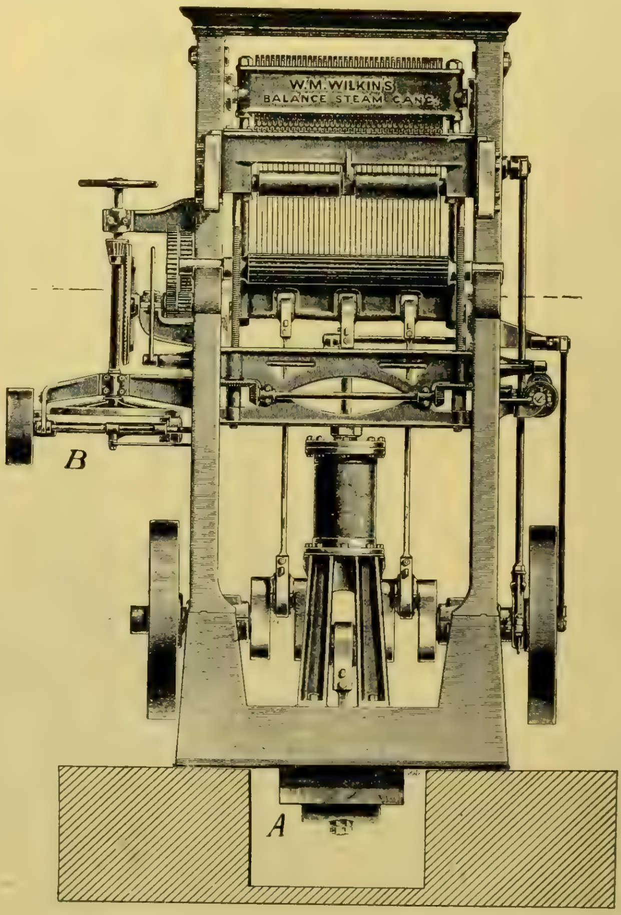

FIG. 13. AMERICAN GANG MILL FOR LOGS.
With direct steam driving, and opposing reciprocating counterbalance.

The future of band sawing is hard to foresee. The speed of performance is marvellous. A thin saw moving at one hundred feet a second has scarce a limit of cutting rate. In reports at hand on the performance of machines, some of the statements seem incredible. The amount of timber, reckoned by board measure, is from 20,000 to 80,000 feet per diem. In one case the average amount, for fifteen consecutive days, was 200,000 feet a day in hard woods, the band-saw having thus fully equalled the performance of the circular-saw.

Band saws are applicable to rough work, such as squaring or slabbing balks for gang saws, and, in one case reported from Clinton, Iowa, a band sawing machine squared an average of 130 logs a day for two and a half months consecutively.

Band resawing machines, for second reduction, as practised in the United States, usually after the timber is seasoned, have been the most difficult of all to bring into practical working form, especially for sawing the soft, spongy kinds of wood. Slow feeding dulls the saws out of all proportion to the amount of work done, and fast feeding causes deviation through packing of the sawdust. It may be said that the result would be the same with any kind of saw,—which is true, supposing the thickness the same.

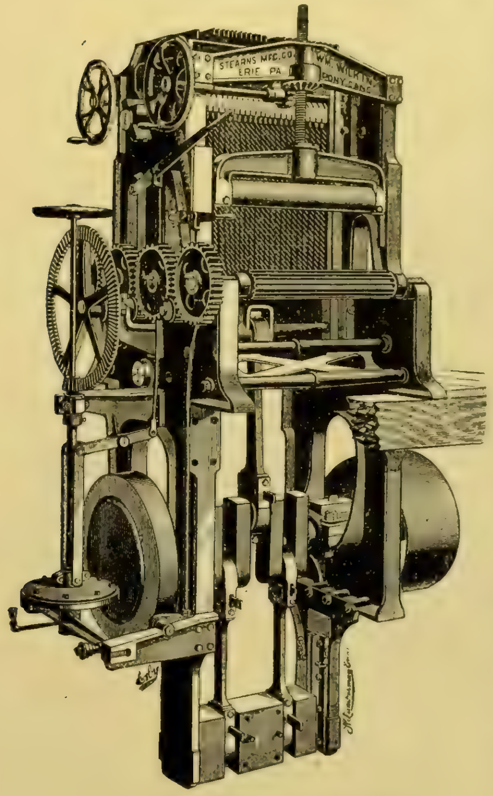

FIG. 14. LOG GANG-SAW MILL.
With roller feed and reciprocating counterbalance, variable friction feed, and belt driving.

The projection of teeth, and consequently of the dust space between them, is as the thickness of a plate. The lateral rigidity of the teeth also depends upon their thickness; so, the thinner the saws, the more difficult it is to operate them in deep sawing and in dry timber that contains soft pitch or is of a fibrous nature. A wide pitch, or space between the teeth, is best, and a curve under, or in advance of, the teeth is better than an acute angle.

It is, however, to be questioned if band saws are as suitable for resawing dry timber, or any kind of square sections, as gang saws are, when several cuts can be made at the same time; but gang sawing, while it is the common method in Europe, as will appear in future illustrations, does not meet present requirements in the United States.

Deals from 9 to 13 inches wide and 3 inches thick can be rapidly sawn, either edgewise or flatwise, by gang saws, but boards or planks from 20 to 30 inches deep, to be sawn with one cut, present quite another problem. A logical method for such sawing, and one too much neglected, is to spread the pieces behind the saws, and thus give clearance for the saw-dust. This requires strong feeding devices and firm support for the timber in advance of the saws; but these are simple provisions, and not expensive.

Gang saws, while they occupy a prominent place in timber-sawing in the United States, especially in the large merchant mills, have not the important place accorded to them in Europe. Reasons for this are the greater first cost of the machinery and foundation structures; the cheapness of forest timber, which renders kerf waste a less serious matter; and the straightness of the timber, which permits it to be cut on carriages with a straight-line movement. This subject will be further explained presently.

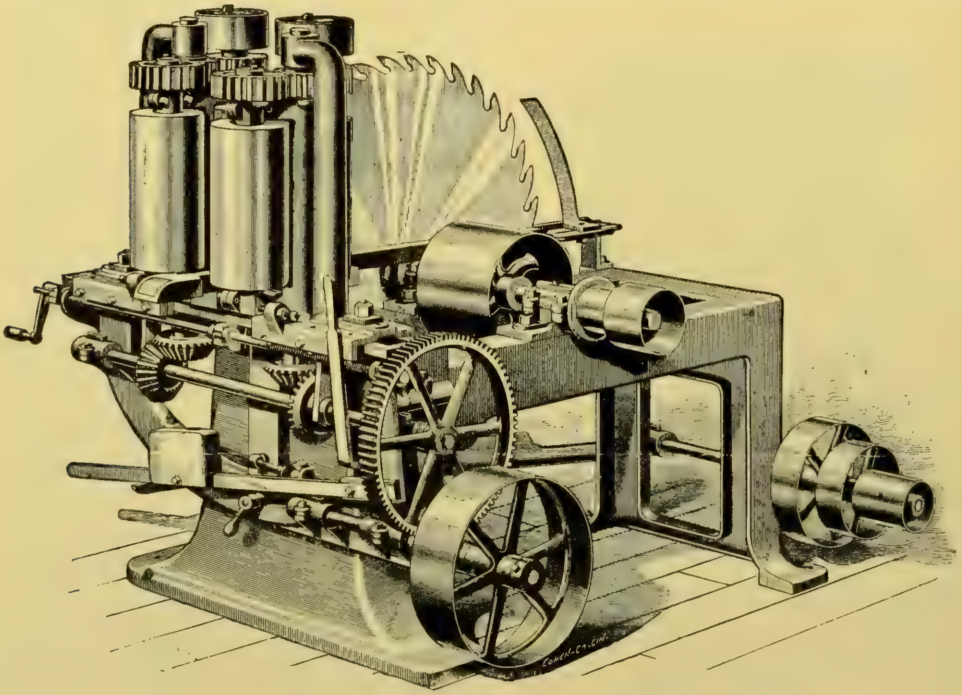
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FIG. 15. AMERICAN CIRCULAR RESAWING MACHINE.

Arranged to use either solid or segmental saws. This form has been largely superseded by band resawing machines.

American practice in gang-sawing machines is diversified, the machinery being usually "built in," and made to special plans in each case. There is no "manufacture" of such machines, as there is in Europe, where they are made to regular lists, sent to various parts of the world, and erected on earth foundations.

The illustrations, and the notes accompanying them, will serve to explain common practice, or, at least, will be typical of self-contained machines.

STANDARD SPECIFICATIONS FOR STEEL.

By William R. Webster.

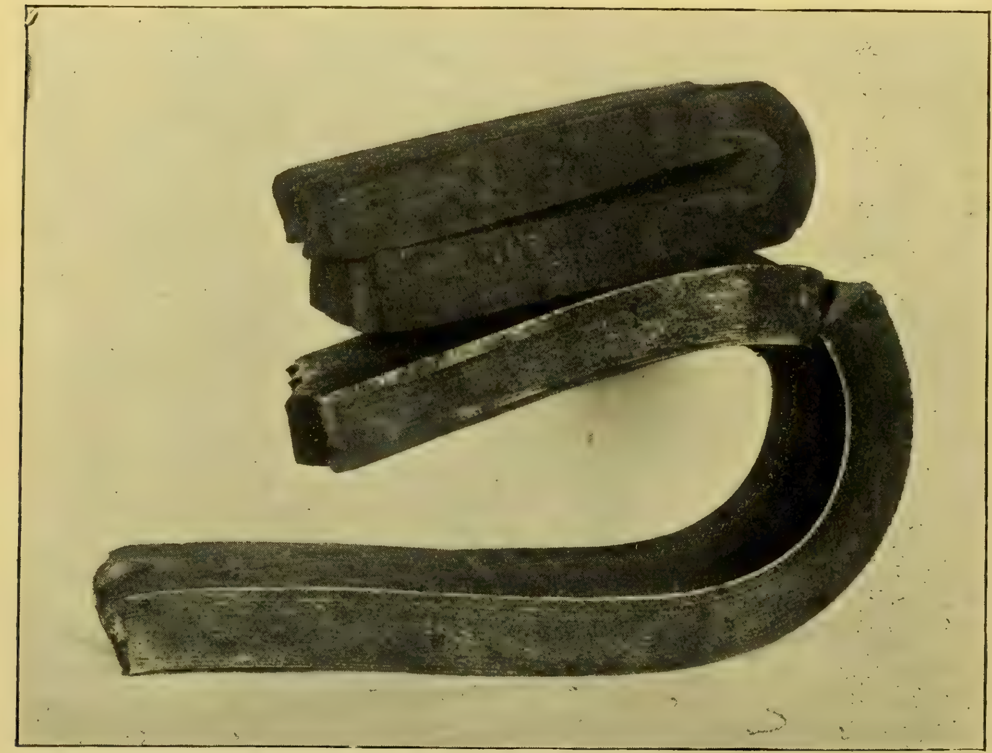
IN the United States the gradual change from the use of iron to steel has been brought about without serious trouble. It was accelerated by the government engineers in taking a firm stand, from the very first, that the requirements of their specifications, both as to quality of material and workmanship, should be lived up to in every particular, and by the same insistence on the part of some of the leading civil engineers. This compelled the steel makers to pay the closest attention to every detail of the manufacture, and, in order to meet the new conditions and not injure the metal, it became necessary for the shops to put in new machinery,—for instance, plate-planing machines, radial drills, reamers, etc.

It was soon shown that the quality of the finished steel did not depend alone on its chemical composition, but that the amount of work it received in rolling or forging, and the finishing temperature, were also of vital importance. Although this has been known in a general way for years, we are still learning, year by year, better to distinguish the effects due to each, and are getting to-day results that were formerly considered impossible. I refer to the method in use at some American mills, where they roll the steel into plates, shapes, etc., meeting all the requirements of the most rigid specifications without making any preliminary tension tests. This great advance has been brought about by the closest observation of the methods of manufacture, and the establishment of the relation between the chemical composition and the physical properties of steel. They proceed as follows:

An analysis of each heat or cast is made while the ingots are still in the soaking pits; from this analysis the ultimate strength is estimated; and, without allowing the steel to cool from its original casting temperature, it is rolled on orders where, as shown by the estimated ultimate strength, it will apply, due allowance being made, of course, for the thickness of the finished product.

This does not in any way relieve the mills from the usual tension tests required of the finished material; but it is of the greatest assistance, both to the manufacturer and the inspector, in checking the uniformity of the steel; as, when heats of steel of about the same chemical composition do not give, approximately, the same physical results, the indications strongly point to irregularities in working, and show where to locate the trouble.

I have made a special point of the heat treatment of steel in connection with work, as it has so great an effect on the structure and quality of the finished material, and as steel of the very best chemical composition can be made brittle and unfit for use (in that condition) by being finished at too high temperature. This trouble increases with the increase of carbon, and also with the increase in thickness of the finished material, and is more likely to occur where heavy sections are rolled on a light mill. When very heavy plates are to be used, it is advisable to anneal them, and take no chances of brittleness caused by too high finishing temperature. By annealing I do not mean the slow cooling from the finishing temperature ; I mean that the plates should be allowed to cool in the ordinary manner, and then be heated to the proper temperature for annealing.



COLD BEND AND QUENCH BEND OF 3-INCH X ⅝-INCH STEEL TEST PIECE.
These are the tests referred to by Mr. Wille in his remarks quoted on page 949.

In this connection I quote the following from my remarks on specifications before the Franklin Institute (November, 1898), and remarks by Mr. H. V. Wille, in the discussion of same, with the photograph of the bending tests referred to :

> Too much importance is paid to the quench bends. In some cases the cold bends have been entirely omitted, the quench bends substituted, and considered a reliable test as showing the quality of the material. Now, this is all wrong, as soft steel which has been finished at too high temperature, and thus rendered brittle so that it will not stand the ordinary cold bends, may be restored by the heating, and, the car-

bon being so low that the subsequent quenching does not harden this class of material, it then bends 180° flat on itself without cracking. Material accepted under these conditions has failed under subsequent shop work: but it would have been rejected at the mills, had the ordinary cold bends been made.

Mr. Wille's remarks were as follows:

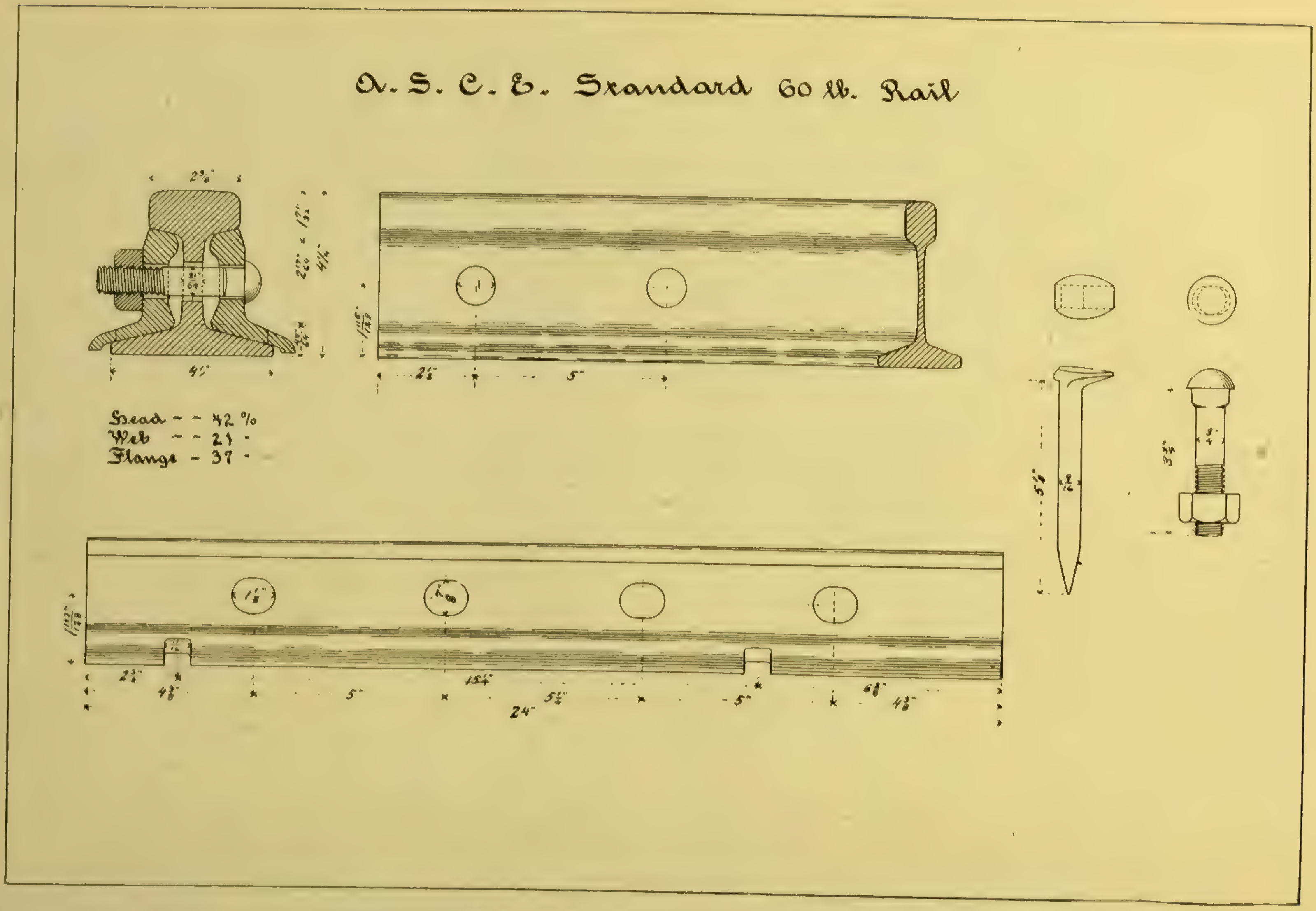
I cannot too strongly endorse Mr. Webster's remarks on the heat treatment of steel, especially those in reference to quench and ordinary bending test. A sample of steel recently came under my observation which, when judged by the tensile strength, reduction of area, elongation, and chemical analysis, would be regarded as the highest grade of material, and, in fact, it passed two inspections on such tests. Notwithstanding the results of these tests, the plate cracked in numerous places, at the holes, when an effort was made to roll to a 60-inch ring. A test was now cut from the plate, and failed, as you will see by this sample, on ordinary cold bend; but a second test cut from the same portion of the plate, when heated to dull cherry and quenched in water, bent flat without signs of distress, proving that a good plate of steel was injured by finishing at an improper temperature. The quality of the steel can be judged by the following tests:

Tensile strength, lbs. per sq. in.	59,200
Elongation % 8″ section	28.
Reduction of area, %	60.2
Carbon	.24%
Manganese	.39%
Phosphorus	.012%
Sulphur	.020%
Silicon	.020%
Copper	trace.

To-day we are hearing less of the mysterious failures of steel than ever before, as, when a failure occurs, examination nearly always shows that the cause was improper heat treatment or bad shop practice, and not chemically-poor steel. To prove this, good steel has been taken, with which similar failures have been produced at will by the same treatment.

When basic open-hearth steel was first made in the United States, stock high in phosphorus was used; but it was soon found that this did not give a uniform steel. A stock much lower in phosphorus is now used, and the resulting steel is uniform and in every respect satisfactory. It is used in bridges and all other classes of work on an equality with acid open-hearth steel, and it will equally meet any tests met by the latter. The worst that can be said against basic open-hearth steel, as now made, is its name, as it is often confused with the basic bessemer steel, or basic open-hearth steel made from stock high in phosphorus.

In basic bessemer steel and basic open-hearth steel made from stock high in phosphorus, there is danger of rephosphorization of the steel from the highly-phosphoric slag. This danger is eliminated in the basic open-hearth, when a stock low in phosphorus is



AMERICAN SOCIETY OF CIVIL ENGINEERS' STANDARD 60-LB. STEEL RAIL.

used. Another important fact to be considered in this connection is that, when stock high in phosphorus is used in making basic open-hearth steel, the carbon is burned out before the phosphorus, and the metal, being left unprotected, is easily oxidized. This oxidation is not removed by the subsequent addition of manganese, and we sometimes have irregular and brittle steel from this cause. When a stock low in phosphorus is used in this process, the phosphorus is removed before the carbon, and the steel, being protected by the carbon, is not liable to be oxidized. This shows clearly the causes of the great superiority of the basic open-hearth steel as now made in the United States.

Mr. C. E. Strohmeyer fully appreciates the good qualities of basic open-hearth steel when made from stock low in phosphorus. In a recent paper, read before the Institution of Engineers and Shipbuilders, Glasgow, he explained in detail the properties of this metal, which he calls "Basic Refined Steel." I quote the following:

> My opportunities to study what I ventured to call basic refined steel, and comparing it with acid steel, have been exceptionally favorable and extensive, both in English, German, Belgian, and Austrian works, and I believe that this experience may help to familiarize the members of this Institution with a material which has proved itself equal, if not superior, to steel made in this country. Although it is produced in a basic furnace, I do not wish to class it with the two other basic qualities which are made, respectively, in a Thomas (basic) converter or in a basic open hearth, because these two qualities have not earned for themselves in this country a good reputation in ship-building yards and boiler shops. In fact, the word "basic," when applied to steel, is to many ears but another word for "rotten." To tell shipbuilders in this country that German ships and boilers are almost exclusively built of "basic" steel awakens their curiosity, but to volunteer the further information that failures with such plates are rare is to court being regarded as a romancer. Although the details of the manufacture of acid steel are sufficiently well-known in this district, it will be necessary to refer to them occasionally; and, as there are three basic processes, and not merely two, as is generally supposed, they will have to be discussed somewhat in detail.

Mr. Strohmeyer then fully explains the differences and details in the manufacture of the three kinds of basic steel, and gives the results of a large series of tension and bending tests, etc. After comparing the results, he closes the article with the following statement:

> These results confirm the opinion which is universally held on the continent,—that the two steels, although they both go by the name of "basic," cannot, as is done in this country, be classed together. It has been my endeavor to make this clear, and, if possible, to pave the way for the introduction of what I have ventured to call basic refined steel,—a material which seems to surpass that produced in the acid open-hearth, and which may, perhaps, be the stepping-stone to higher limits of tenacity, and further reductions of scantlings.

All that has been said by Mr. Strohmeyer in favor of the use of basic refined steel, as made on the continent, equally applies to the basic open-hearth steel as made in the United States, and confirms the good opinion that the government engineers and leading civil engineers of the United States have of this material.

Most of the American specifications are very satisfactory both to manufacturers and consumers; they do not impose too rigorous requirements on the steelmakers or the shops doing the work, yet, if properly enforced, they are sufficient to insure good material and workmanship.

In my own work as consulting and inspecting engineer, I have found requirements in specifications for material on export orders that were so entirely different, in minor details, from the usual practice in the United States as to cause considerable trouble and annoyance, as well as delay; and, on visiting the works abroad, I was surprised at the ease with which many of these requirements were met. Take, for instance, the drilling of oval holes in the web of rails. In this and similar cases the American manufacturers simply did not know how to accomplish the results in the easiest manner; but I am glad to state that, in all the essential matters, they gave the same or equivalent results, and I feel assured that, had orders subject to standard American specifications been placed with foreign manufacturers, they would have experienced similar trouble. This is owing to the different methods in use in the various countries, both in the manufacture of materials and the methods of testing.

The ordinary methods of making and preparing tests should be reduced to a standard. Take, for instance, tension tests. The pulling speed should be specified, and the relation between the width of test-pieces and thicknesses of material should be fixed. About three widths would be sufficient to cover all ordinary thicknesses, and they could be prepared without any increased cost. We also need some simple machine for making impact tests, as the ordinary tension and bending tests do not show all the properties of the material as regards resistance to shock.

Some years ago having been called upon to inspect rails and accessories to be made in the United States subject to foreign specifications, I found it necessary to remodel the specifications in order to comply with American practice, and at the same time retain the essential features of the original specifications. The following specification is one which I prepared under these conditions (for 60-pound rails and accessories) at the request of the engineer of a large foreign railroad, who adopted them after thoroughly investigating the practice and methods of manufacture in the United States, fully appreciating that his former specifications would cause trouble in minor points, which could be covered by equivalent requirements not in conflict with American methods of manufacture and testing. They have also been adopted by several other foreign railroads, and thousands of tons of rails and accessories manufactured under them have given perfect satisfaction in use.

STANDARD SPECIFICATIONS FOR 60-POUND BESSEMER STEEL RAILS, AND ACCESSORIES.

All of the materials are to be manufactured in the best possible manner, and in accordance with the requirements of this specification.

Chemistry.—Clause No. 1. The steel to contain .35 per cent. to .45 per cent. Carbon, aiming at .40 per cent. Manganese not over .90 per cent., Phosphorus not over .10 per cent., and Sulphur not over .06 per cent.

Section.—Clause No. 2. The section of rail rolled to conform as accurately as possible to the attached drawing, a template of which to be furnished by the manufacturer. A variation in height of $\frac{1}{64}$ of an inch under and $\frac{1}{32}$ of an inch over will be permitted. The fit of the angle fish plate shall be maintained perfect.

Weight.—Clause No. 3. The weight of rails to be kept as near to 60 pounds per yard as practicable, after complying with Clause No. 2. A variation of 1 per cent. in individual rails, and $\frac{1}{2}$ of 1 per cent. in the entire order, will be allowed. At least one rail per hour shall be weighed during rolling, to prevent greater variation than that specified.

Tests.—Clause No. 4. One drop test will be made on a piece of rail not over 6 feet long from each blow of steel, with drop weighing 2,000 pounds, having a striking face with a radius of not over 5 inches, falling 16 feet, on rail placed, head up, on solid supports 3 feet apart. If any rail breaks under this test, two more tests will be made of other rails from same blow, and, if either of these tests fails, all the rails of this blow will be rejected.

Lengths.—Clause No. 5. The standard length of rails to be 30 feet. Shorter lengths up to 10 per cent. of the order, if made, will be accepted in lengths of 28 feet, 26 feet, 24 feet, 21 feet, and 18 feet. But the three shorter lengths must be supplied as follows:

Not less than per cent. of 24 feet,
" " " per cent. of 21 feet,
" " " per cent. of 18 feet.

The usual variation of $\frac{1}{4}$ inch above or below the specified lengths will be allowed.

When rails are ordered of special lengths slightly shorter than 30 feet, for curves, in order to readily distinguish these rails, the ends are to be painted with white lead. and they are to be taken with the 30-foot lengths in the above schedule.

Drilling.—Clause No. 6. Circular holes 1 inch in diameter to be accurately drilled in accordance with the accompanying drawing. The burrs caused by drilling to be carefully removed.

Finish.—Clause No. 7. The ends of rails to be cut perfectly square; the burrs caused by sawing carefully removed by chipping and filing. The rails must be free from all mechanical defects and flaws; and shall be straight both in surface and line. In the process of straightening, no blows must be used; the rails are to be straightened by gradual pressure, and the gag to have sufficient bearing surface so as not to indent the rails.

Branding.—Clause No. 8. The name or initial of manufacturer, the year and month of rolling, the Railway Co.'s symbol ( ), to be rolled on the web of the rail, and the blow number to be stamped on the web of each rail.

Inspection.—Clause No. 9. The inspector shall be notified in advance of the time of rolling any part of the order, shall have free access to the works at all times during the manufacture, and have all reasonable facilities afforded, to satisfy him that the materials are being manufactured in accordance with these specifications. The manufacturer shall defray the expense of all tests made at his works to determine the uniform quality of the steel used; and shall furnish the inspector, daily, with the carbon determinations of each blow of steel used, and a complete chemical analysis, every twelve hours, giving the average of the other elements contained in the steel.

Conditions of Rolling.—Clause No. 10. The entire process of manufacture and testing to be in accordance with the best standard practice of to-day. special care being given to the following: Ingots to be kept in a vertical position in the soaking pits, no bled ingots to be used, sufficient discard from the top of the ingots to insure sound rails, uniform temperature of heating, and *uniform finishing temperature in rolling.*

Lighter or Heavier Rails.—Clause No. 11. If rails of lighter or heavier weight than 60 pounds per yard are rolled subject to these specifications, the necessary change in chemical composition and drop tests will be decided by the consulting engineer.

STEEL ANGLE FISH PLATES.

Chemistry Tests.—Clause No. 12. The material to be bessemer steel containing not over .15 per cent. Carbon, .10 per cent. Phosphorus, or .06 per cent. Sulphur, with an ultimate strength of not over 64,000 pounds per square inch; and 25 per cent. elongation in 8 inches. The full-sized fish plate to bend flat cold, without showing any signs of cracks on the outside of bend.

Length, Section, Fit, Weight, Punching, Notching.—Clause No. 13. The angle fish plates to be 24 inches long and rolled to a template representing the accompanying drawing; they shall be perfectly straight and free from all surface defects, ends square and free from burrs, and shall have a perfect fit to the rail for which they are intended. In order to check this, two pieces of rails, properly drilled, must be furnished from each rolling; and a complete splice made. The weight to be within 2 per cent. of that specified. The oval bolt holes to be accurately punched from the rail side of the fish plate outward, in order that the taper of the punched hole may correspond with the taper under the head of bolt, and spike notches punched in flange with well-defined fillets in corners. This work to be done in such a manner as not to distort or injure the bars. The dimensions and position of holes and notches to be exactly as shown in drawing.

Branding.—Clause No. 14. The initials of the manufacturer and year of rolling to be rolled on the bars.

Analyses, Testing.—Clause No. 15. The manufacturer to furnish the inspector with full chemical analyses of the steel used, and the inspector will make sufficient tension and bending tests to satisfy himself that the material is in accordance with these specifications.

Oiling.—Clause No. 16. The finished angle fish plates to be dipped in boiled linseed oil and securely wired in bundles.

BOLTS.

Chemistry, Tests.—Clause No. 17. To be manufactured of bessemer steel, containing not over .10 per cent. Carbon, .10 per cent. Phosphorus, or .06 per cent. Sulphur, with an ultimate strength of not over 64,000 pounds per square inch, and 25 per cent. elongation in 8 inches. The bars to bend flat cold.

Dimensions.—Clause No. 18. The bolts to conform in all respects to the dimensions shown in the accompanying drawing. The heads to be forged from the solid, free from fins or defects, and the bearing faces of the head and nut to be square with the axis of the bolt.

Threads.—Clause No. 19 The threads to be United States or Whitworth standards, cleanly and accurately cut, so that any nut will fit any bolt in such manner that it can be screwed on by hand to to three-fourths of the thickness of nut, and then fit so tightly that they cannot be moved without the use of a spanner.

Oiling.—Clause No. 20. The finished bolts and nuts are to be heated and dipped in boiled linseed oil, and packed in strong six-hooped kegs of 150 pounds' capacity.

Iron Bolts.—Clause No. 21. If iron bolts are used, the material must be tough and fibrous, having an ultimate strength of 50,000 pounds per square inch, 15 per cent. elongation in 8 inches, and bend cold 180° over once the thickness of the bar. All other conditions to be the same as for steel.

SPIKES.

Chemistry, Tests.—Clause No. 22. To be manufactured of bessemer steel, containing not over .10 per cent. Carbon, .10 per cent. Phosphorus, or .06 per cent. Sulphur, with an ultimate strength of not over 64,000 pounds per square inch, and 25 per cent. elongation in 8 inches. The bars or finished spikes to bend flat cold, without showing any cracks on the outside of bend.

Dimensions.—Clause No. 23. The spikes to conform in all respects to the dimensions shown in the accompanying drawing; to be straight, clean, and free from defects. The heads must be forged from the solid, and underside of heads to correspond with the bevel of flange of rail, and must be capable of being straightened out flat, under the hammer, both before or after the neck has been ground half through.

Oiling.—Clause No. 24. The finished spikes are to be heated and dipped in boiled linseed oil, and packed in strong six-hooped kegs of 150 pounds' capacity.

Iron Spikes.—Clause No. 25. If iron spikes are used, the material must be tough and fibrous, having an ultimate strength of 50,000 pounds per square inch, 15 per cent. elongation in 8 inches, and the bar or finished spike to bend cold 180° over once the thickness of the bar. The heads to be flattened out under the hammer, and the results such as to show that the material has not been injured in forging. All other conditions to be the same as for steel.

After taking into consideration the large daily output of modern mills, these specifications were drawn up in accordance with my system of inspection, and they aim to control the quality of the steel used, without delaying the mills with unnecessary requirements. The drop test from each blow of steel (which represents the shock the rails must resist in service), in connection with the chemical composition, checks the uniformity of the steel, and prevents inferior material from being accepted.

The limit of not more than .10 per cent. phosphorus in my specification is the standard requirement of leading American railroads and engineers. The railmakers are accustomed to it, and fully understand that, when the phosphorus approaches this limit, the other elements must be kept within well-defined limits, in order to produce the best results. This is done, and rails are made meeting all the requirements of drop tests, and all the conditions of service on railroads in the United States and in other countries.

A few American rail specifications call for a phosphorus limit of not more than .06 per cent.; but this is generally considered an expensive luxury, as no basic bessemer steel rails are made in the country, and it is very doubtful if rails low in phosphorus have all the additional advantages claimed.

In some European specifications for rails the same requirement of not more than .06 per cent. phosphorus appears; but this is not at all difficult to comply with where basic bessemer steel is made, or in the few localities having ores low in phosphorus. But, notwithstanding all this, there seems to be a decided difference of opinion as to the phosphorus limit and other chemical requirements. No less an authority than Mr. C. P. Sandberg said at the Stockholm meeting of the Iron and Steel Institute, in 1898:

> The railway congress in Paris, in 1889, demanded rather hard steel rail, but the congress in London, in 1895, would not sanction it. I trust that at the coming congress in Paris, in 1900, engineers will leave out the chemical composition in their specifications altogether, and only demand an adequate tup test for safety, as well as a limited deflection to secure the required hardness, leaving out the tensile tests altogether. These latter are entirely out of place for rails, which are subjected in use to blow or impact; besides, tensile tests are both slow and costly for the preparation of test pieces.
>
> The rail is subject to a blow in practice, and therefore should be tested with a blow. The tup test could be done with one rail end for each cast, and the maximum deflection to specify for each rail section could be obtained by experience in testing rails of the required hardness in each rail section to serve for a hardness as well as a safety test. This system of combined testing would cost next to nothing, and would not delay the inspection of the rails.

There are many reasons why the chemical requirements should not be abandoned in rail specifications. They compel the steelmaker to pay the closest attention to his methods of manufacture, and the resultant steel is more uniform than it otherwise would be.

What is needed is more light on the effect of the different chemical elements on the finished rails. At the present time there are wide differences of opinion on this subject, but I am firmly convinced that, in the end, the general decision will favor steel of fixed chemical composition for the different weights of rails that, in connection with the proper finishing temperature, will make the toughest, safest, and best-wearing rails.

Enough has been written to call attention, in a general way, to the differences between the specifications and methods of testing in the United States and other countries. This is the strongest plea for coöperation with the International Association for the Testing of Materials; and engineers and manufacturers should give freely all the information they have to enable the association to complete its international specifications.

MACHINE-TOOL DEPRECIATION AS AN ELEMENT OF MANUFACTURING COST.

By H. M. Norris.

MY preceding paper concluded with a discussion of the general principles underlying a correct estimation of the original value and subsequent depreciation of foundry patterns. Let us now consider some of the essentials of the following classifications of capital.

"Standard machinery and tools," is intended to include only such plant as may be regarded as possessing universal value,—*i. e.*, machinery of a customary kind, which, though subject to improvement, is of use in so many kindred trades that it retains a fair value till worn out, even if sold under the hammer to other users.

The deterioration of machinery of this class depends upon many circumstances, chief among which are quality and mode of using. Mr. Warner states in his letter that "low-grade tools are in a sad state of dissolution before completion," and that "it is often most profitable to condemn them before starting." Some young, struggling concern, attempting to do business with insufficient capital, may be forced to purchase tools which will shortly have to be replaced by something better, but the installation of low grade tools by such firms as have the necessary funds to procure the best the market affords immediately marks them penny-wise and pound-foolish. The efficiency of the operator cannot disguise the ultimate expensiveness of a poorly-designed and badly-put-together machine. Its best place is the scrap-heap or some one else's shop. On the other hand, a high-grade tool treated with proper care will retain its usefulness a long time, as demonstrated in the second letter of the previous issue. It is obvious, therefore, that, in order to estimate correctly the alterations in value which machinery of this class undergoes from year to year, it is necessary to keep three main factors in view: (1) original cost; (2) probable working life; (3) ultimate selling value.

The "original cost" of a machine must not be confounded with its original value. The former means cost of purchase only, while the latter includes the additional expense of installation. At which of these figures should a machine be inventoried? Mr. Lewis, apropos of a lathe purchased and charged to plant, answers the question thus:

> In the first instance, the lathe would be ordered in the ordinary way by a supplier's order and debited to stores account. A works order would be issued for a new lathe, as an addition to plant. The lathe would be drawn out of stores, say to

works order number P. A. 3,217, to which all labor and material absorbed in its erection would be charged. When completed, the prime cost book will show the cost of the whole,—*viz.*, lathe, labor, and material. The establishment charge percentage is then added to prime cost, and the total abstracted to the plant ledger account.

"If the machines are appropriate for their purpose," says Mr. Matheson, "then their value will be arrived at by adding to their original cost the expense of installation, and deducting an amount for depreciation proportioned to their age and wear, and a further amount for any actual repairs they may require."

Are these premises correct? It is my opinion that they are not, except in so far as they apply to a valuation made on account of a change of ownership. They certainly should not be permitted to effect a scheme of depreciation for wear and tear. Expenditures for freight, hauling, and setting up in place ready for running, undoubtedly represent a part of the cost of a new machine; but, since all outlays of this nature are irrecoverable, they should not be given a place on the inventory. The foundation of a machine, and the cost of erecting its countershaft, are of no value to a second purchaser. In fact, the owner is put to the additional expense of taking down the countershaft at the time of sale. If we follow the opposite course, however, and charge the cost of installation to general expense, as practised by some firms, how shall we account to our stockholders for the full amount of their investment? We cannot inventory our expenses, nor can we say (to quote from one of Mr. Oberlin Smith's arguments against the too rapid depreciation of machinery): "Gentlemen, our assets last week, when you paid in your money, were $100,000, but they are now only $50,000, as much of this plant could not be sold, for other purposes than those intended, for nearly the sum which we yesterday paid." To what, then, shall we charge this outlay? Mr. Smith says:

> The grand principle which lies at the root of correct valuation, and which should govern the appraiser throughout all his work, is that any article is worth, not what it *did cost*, but *what it would cost to replace it to-day*, providing it is so useful that it would be desirable to so replace it, were it destroyed Thus, if a shop has a lot of machine tools which are built so near to the best modern practice that it would be desirable to duplicate them were they destroyed, they are worth exactly what said duplicates would now cost, delivered and set up in the shop, less the depreciation due to the wear and tear.

This is unquestionably a good rule to observe when adjudging the value of a machine as delivered to the purchaser, but does it apply to its value "delivered and set up in the shop"? To make an inventory is to prepare a schedule of assets, and assets are property in possession,—*i. e.*, property that is convertible into money or has a cash value. Value has many significations. Thus, there is the value to the owner of a plant taken by compulsory purchase; there is the value to partners of a shop in full operation; the value to a purchaser of a factory as a going concern; the rateable value; the value of a plant, as a whole, that has stopped working; the value of a plant that is dismantled and sold separately; and the value obtainable by forced sale. The value with which we are dealing, however, is the sum a thing will bring, if sold to close out business or to give place to new plant. It is the number of dollars a thing will sell for in the market. The outlay incident to the setting-up of a machine is lost the moment it is moved from its original position, and can in no wise be regarded as convertible property. In point of fact, it is not property at all, any more than the cost of advertising is property. Both are necessary to the starting and running of a business, but neither has a marketable value. They must, however, be accounted for to the stockholders. The original cost of a machine is gradually made good by allowance for depreciation, which system *may* be applied to the cost of installation; but a little study will show that this course is not advisable, since we want the depreciated value in the books at time of inventory to represent assets, and cost of installation is not an asset, but a liability to the stockholders. Hence the cost of installation should be charged to preliminary expenses, and be written off independent of the machines proper, leaving only the purchase price as a basis of calculation.

The probable working life of a machine varies in every trade, and for every class of machine. Care in management, hours of actual work, and severity of working all contribute to its deterioration. Protection from dirt, and the use of good oil, sometimes render one machine twice as durable as another. In some shops overtime is the constant practice, and a corresponding shortening of life ensues. A machine has a certain margin of strength, beyond which it cannot be forced without great detriment. Mr. Matheson says:

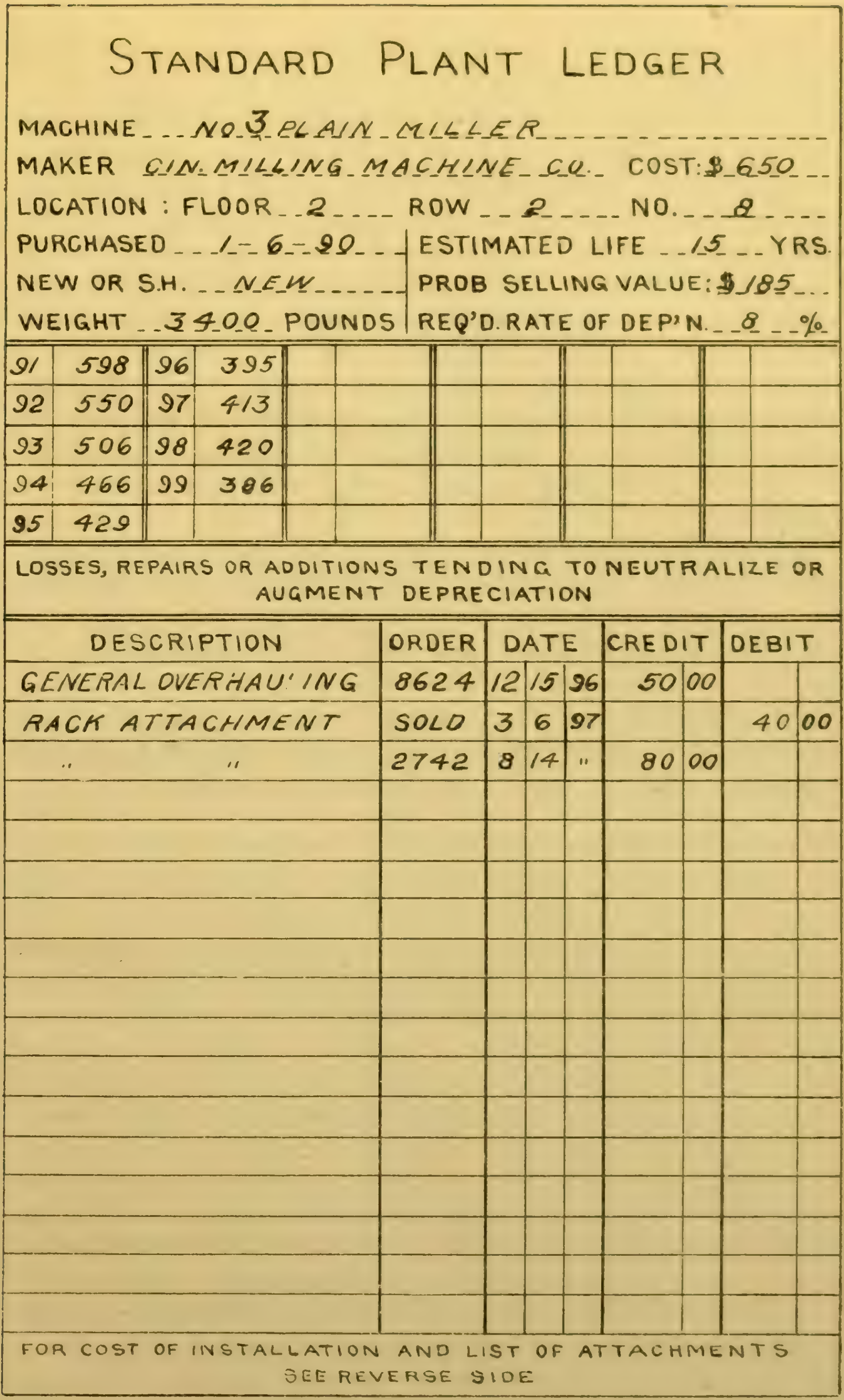
> Where the production is stimulated by a system of piece-work, the deterioration of the plant is likely to be more rapid than in a factory where the workmen are paid according to time only. In very busy times, when there is a very pressing demand for the products, and profits are large, it may be expedient and remunerative to work long hours, and to force the plant and machinery to their utmost power, even at the risk of a breakdown, so as to take full advantage of the transient high prices; but in such a case a corresponding rate would have to be written off for depreciation.

The ultimate selling value is the value a machine will have when discarded by its present owners, either on account of wear, or in order to make room for a more modern tool; at its minimum, it is equal merely to the scrap-value, or the price of old material, less the expense of removal and breaking-up. It is not, therefore, the original cost which must be provided for in deciding upon a appropriate rate of depreciation, but that cost less an amount equal to the value of the material prepared for re-use. The contingency of existing plant becoming obsolete must also be considered. Mr. Matheson says:

> There is a wide range within which values may alter, but a proper estimate may be approached, and the issues narrowed, by regarding first the extreme limits of value. For instance, the highest value of any machine will be the cost of a similar machine, ready for immediate use, together with the expenses of installation. If invention and skill have been bestowed on any additions, a higher value may have been reached than is represented by the original cost and the subsequent outlay, and notwithstanding that the machine is partly worn. The best proof of efficiency in a machine may be afforded by actual working. . . . The lowest extreme is represented by the scrap value, or the price which may be depended on for the old material. The relation which this lowest value bears to the original cost obviously depends on the proportionate value of the materials and that of the labor that has been bestowed upon them. Articles of copper and brass may have a scrap value approaching nearly to the price when new. So also may articles of cheaper materials, if of a simple kind. Thus, old rails, or railway chairs, may be worth as scrap iron half their original value. On the other hand, the scrap value of light and intricate machinery may be a mere fraction of the original cost. Again, the value of old material is sometimes greatly reduced by the cost of preparing it for re-use; such is the case with the removal and breaking-up of cumbrous and heavy iron work.

Deterioration takes place much more rapidly in some classes of machinery than in others. Boilers require a higher rate of depreciation than engines, and engines a higher rate than machine tools, but, whatever the rate, it should be estimated liberally for the first few years, when revision will show whether it needs alteration. Generally speaking, machine tools depreciate in ten years to something less than half of their original cost, however thorough the up-keep. If a well-made milling machine cost $650, it would be prudent to write off 8 per cent. the first year, and afterwards at the same rate annually from the diminishing value, this, in most cases, being sufficient, if all repairs and renewals are paid for out of revenue. In three years its book-value would stand at $506, and in six years at $395. If repairs amounting to $50 are then found necessary, this amount may be added to the capital value, the depreciation rate of 8 per cent. continuing for three years longer, till the value is reduced to $386, when, in all probability, it will be expedient to replace it with a more modern machine. The reason for the small decrease in the last three years appears in Fig. 1.

The capital value of a machine should be increased by only two kinds of expenditures,—*viz.*, the renewal of worn-out parts, and the enlarging or strengthening of the tool as a whole, so as to increase its earning capacity or selling value. Both of these outlays may be regarded as helping to neutralize its depreciation, but they should be applied with great discretion. The soundest way is to charge all repairs and renewals to general expense, but this precaution is unnec-



STANDARD PLANT LEDGER

MACHINE NO 3 PLAIN MILLER

MAKER CIN. MILLING MACHINE CO. COST: $ 650

LOCATION : FLOOR 2 ROW 2 NO. 8

PURCHASED 1-6-90 | ESTIMATED LIFE 15 YRS.

NEW OR S.H. NEW | PROB SELLING VALUE: $185

WEIGHT 3400 POUNDS | REQ'D. RATE OF DEP'N. 8 %

91	598	96	395								
92	550	97	413								
93	506	98	420								
94	466	99	386								
95	429										

LOSSES, REPAIRS OR ADDITIONS TENDING TO NEUTRALIZE OR AUGMENT DEPRECIATION

DESCRIPTION	ORDER	DATE			CREDIT		DEBIT	
GENERAL OVERHAU'ING	8624	12	15	96	50	00		
RACK ATTACHMENT	SOLD	3	6	97			40	00
" "	2742	8	14	"	80	00		

FOR COST OF INSTALLATION AND LIST OF ATTACHMENTS SEE REVERSE SIDE

FIG. I. THE "COST OF INSTALLATION AND LIST OF ATTACHMENTS" WILL BE FOUND ON PAGE 967.

essary where the charges are allocated with due regard to their value to the machine.

Calculations of depreciation by the system of writing off a given percentage annually may be greatly facilitated by the use of Table 1, which is taken, in part, from Mr. Matheson's book, and shows the effect of different rates of depreciation for any term up to thirty years. Suppose we want to find the depreciated value in 15 years, at the rate of 5 per cent. per annum, of a machine whose original cost was $1,200. Referring to the 5-per-cent. column, we find .463,291 as the depreciated value of 1 after 15 years, and this multiplied by 1,200 is $555.95, or the depreciated value sought. Again, what will be the value in 25 years of a $6,000 building, if written off at the rate of 2 per cent. per annum? Looking in the table opposite 25 and under 2 per cent., we read .603,466, which multiplied by 6,000 is $3,620.80.

The table is of great assistance in deciding upon a rate of depreciation which, in a given term of years, will provide for the estimated loss. It does not, however, show what generally takes place as regards renewals and additions, which may more than neutralize the depreciation. It is necessary, therefore, to keep an accurate and intelligent record, not only of the original cost, but of all subsequent repairs and additions, as well as of the rate at which each has been written off. This may be very satisfactorily accomplished by means of a plant inventory book, in which entries are made of each machine, together with its belongings and cost of installation, the number of each page corresponding with the number of the machine recorded thereon. A convenient form of ruling for this purpose is shown in Fig. 1. Such a book, if properly kept up, will enable the manager to make such readjustment in rate of depreciation as he may find expedient from time to time. It provides not only for the recording of such outlays for repairs and additions as tend to neutralize depreciation, but for a full and comprehensive history of the capital investment made on every machine in the plant, together with a list of attachments included in the inventory valuation of each. The listing of attachments and loose parts is very important, as all losses must either be made good out of revenue or be subtracted from the value of the machine to which they belonged. The sample page illustrates the mode of writing-off the $650 milling machine already described.

Loose plant, such as drills, reamers, taps, cutters, etc., is not treated in the above matter, which applies to fixed plant only. Small tools give out so rapidly, and require so frequent renewal, that writing off a percentage annually is not a satisfactory method of dealing with them. It would necessitate a rate of about 50 per cent. To treat

TABLE I.*—THE EFFECTS OF DEPRECIATION AT DIFFERENT RATES FOR TERMS OF YEARS.

YEARS.	1%	2%	3%	4%	5%	6%	7%	8%	10%	12%	15%	20%
1	.990,000	.980,000	.970,000	.960,000	.950,000	.940,000	.930,000	.920,000	.900,000	.880,000	.850,000	.800,000
2	.980,100	.960,400	.940,900	.921,600	.902,500	.883,600	.864,900	.846,400	.810,000	.774,400	.722,500	.640,000
3	.970,299	.941,192	.912,673	.884,736	.857,375	.830,584	.804,357	.778,688	.729,000	.681,472	.614,125	.512,000
4	.960,596	.922,368	.885,292	.849,346	.814,506	.780,749	.748,052	.716,392	.656,100	.599,695	.522,006	.409,600
5	.950 990	.903,921	.858,734	.815,372	.773,781	.733,904	.695,688	.659,081	.590,490	.527,731	.443,705	.327,680
6	.941,480	.885,843	.832,972	.782.757	.735,092	.689,870	.646,990	.606,355	.531,441	.464,404	.377,149	.262,144
7	.932,066	.868,126	.807,982	.751,477	.698,337	.648,478	.601.700	.557,846	.478,297	.408,675	.320,577	.209,715
8	.922,745	.850,763	.783,743	.721,389	.663,420	.609,569	.559,581	.513,218	.430,467	.359,634	.272,490	.167,772
9	.913,517	.833,748	.760,231	.692,534	.630,249	.572,995	.520,411	.472,161	.387,420	.316,478	.231,617	.134,218
10	.904,382	.817,073	737,424	.664,832	.598,737	.538,616	.483,982	.434,388	.348,678	.278,500	.196,874	.107,372
11	.895,338	.800,732	.715,301	.638,239	.568,800	.506,299	.450,103	.399,637	.313,811	.245,080	.167,343	.085,899
12	.886,385	.784,717	.693,842	.612,709	.540,360	.475,921	.418,596	.367,666	.282,429	.215,671	.142,232	.068,720
13	.877,522	.769,023	.673,026	.588,201	.513,342	.447,366	.389,294	.338,253	.254,186	.189,790	.120,905	.054,976
14	.868.746	.753,643	.652,836	.564,673	.487,675	.420,524	.362,043	.311,192	.228,768	.167,015	.102,770	.043,981
15	.860,059	.738,570	.633,250	.542,086	.463,291	.395,292	.336,700	.286,297	.205,891	.146,973	.087,354	.035,184
16	.851.458	.723,798	.614,253	.520,402	.440,127	.371,575	.313,131	.263,393	.185,302	.129,336	.074,251	.028,148
17	.842,943	.709,323	.595,825	.499,586	.418,200	.349,281	.291,212	.242,322	.166 772	.113,816	.063,113	.022,518
18	.834,514	.695,136	.577,950	.479,603	.397,214	.328,324	.270,827	.222,936	.150,095	.100,158	.053,646	.018,014
19	.826,169	.681,233	.560,612	.460,419	.377,354	.308,624	.251,869	.205,101	.135,085	.088,139	.045,599	.014.412
20	.817,907	.667,609	.543,794	.442,002	.358,486	.290,107	.234,238	.188,693	.121,577	.077,562	.038,760	.011,529
21	.809,728	.654,257	.527,300	.424,322	.340,562	.272,701	.217,842	.173 597	.109,419	.068,255	.032,946	.009,223
22	.801,631	.641,171	.511,655	.407,349	.323,533	.256,358	.202,593	.159,709	.098,477	.060,064	.028,004	.007,379
23	.793,615	.628,348	.496,306	.391,055	.307,357	.240,958	.188,411	.146,933	.088,629	.052,856	.023,803	.005.903
24	.785,678	.615,781	.481,416	.375,413	.291,989	.226,501	.175,222	.135,178	.079,766	.046,513	.020,233	.004,722
25	.777,822	.603,466	.466,974	.360,396	.277,390	.212,911	.162,957	.124,364	.071,790	.040,921	.017,198	.003.778
26	.770,043	.591,396	.452,965	.345,980	.263,520	.200,136	.151,550	.114,415	.064,611	.036,010	.014,618	.003,022
27	.762,343	.579,568	.439,376	.332,141	.250,344	.188,128	.140,941	.105,261	.058,150	.027,289	.012,425	.002,418
28	.754,720	.567,977	.426,194	.318,855	.237,827	.176,840	.131,075	.096,840	.052,335	.024,014	.010,562	.001,934
29	.747,172	.556,618	.413,408	.306,101	.225,935	.166,230	.121.900	.089,093	.047,101	.021,132	.008,977	.001,547
30	.739,701	.545,485	.401,006	.293,857	.214,639	.156,256	.110,076	.081,966	.042,391	.018,596	.007,631	.001,238

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* For the convenience of readers of THE ENGINEERING MAGAZINE who may desire to keep this table for reference, a reprint of it has been made, upon single sheets, which will be furnished, free of charge, upon application.

them as current expense is much better practice, although some firms prefer to value such articles afresh every year. Others, after a fair valuation has once been fixed, write nothing off thereafter, but maintain and renew out of revenue, which is equivalent to regarding them as consumable stores. A third plan, and one which seems to have met with considerable favor, is to value everything of this kind, whether old or new, at half its original cost. It is doubtful if one plan is much better than another. They are all bad. And it is a question whether it is worth while to attempt more than an approximate determination of their value, which, at best, is all that we could hope to make without the expenditure of immense labor.

"Special tools, jigs, and fixtures," item D, should be classed in a category by themselves, as they are rarely salable as second hand plant, except in so far as they have a scrap-value, or are sold with the business as a whole. The phrase "special tools, jigs, and fixtures," as here used, does not mean such appurtenances as are made on a customer's order for some special work, but special tools devised for the cheapening of standard articles of manufacture. The former have no book value whatever, and should, in consequence, be charged as expense to the particular work for which they were designed. The latter, however, are quite as much a part of capital as any other kind of plant, and should so appear on the books of the company until superseded by more improved devices, or until the work for which they were made is altered or its manufacture discontinued in whole or part.

With some firms this item of asset is comparatively insignificant; with others it is paramount. Special machinery is the most expensive kind of plant, costing usually several times as much as standard plant; and where it constitutes a firm's chief equipment, as is not infrequently the case, it must of necessity be treated as capital.

The true value of special plant may be said to be represented by the value of such ordinary plant as it replaces, plus whatever saving in wages and general expense is effected through its use. Considerations of this nature should not, however, be permitted to enter into an appraisement made for the purpose of establishing a book value, which obviously should be taken at actual cost in all cases where the plant is appropriate to the work for which it was intended. In other words, it should be taken at the valuation of the cheapest plant procurable that will do the work with equal facility. Mr. Smith says*:

> The depreciation of special tools for wear and tear need be but very little, as, if they serve their purpose at all, they must be kept in such repair as to serve it perfectly; and they are not a marketable article in which a slight deterioration in appearance would largely affect their value, as it would be the case with standard articles. . . .

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*"Inventory Valuation of Machinery Plant." Trans. A. S. M. E., Vol. VII., p. 433.

> The rules governing an appraiser may be tersely stated thus: rate all property that it would be desirable to reproduce, were it destroyed to-day, at the net cost of such reproduction, in its existing locality, minus its estimated damage by wear and tear. Rate partially obsolete articles the same way, but minus also a percentage of their apparent value equal to their estimated percentage of obsoleteness or of improbability of usefulness Rate wholly obsolete articles at nothing.

He says further; in a later paper, on the "Intrinsic Value of Special Tools":

> Concerning this subject, there are two principal schools of belief, with a practice, in individual cases, ranging all the way between the extreme views held on either side. The first of these views is that a special tool should not be reckoned as partly obsolete while in the full career of its usefulness, but that very careful watch should be kept for any indications of a lessening demand for the merchandise which the tool is made to produce. The moment such indications appear, depreciation should commence, and should be made rapid enough to be surely on the safe side, and to bring the value of the tool down to nothing but what it is worth for old material, before said marketable demand has entirely ceased. . . . The opposite view regarding valuation of special tools, and one which is held by many shrewd and careful manufacturers, is that they should be depreciated by a large percentage every year, until their value stands *nil* upon the inventory. One popular belief is that a special tool hasn't any value at all until it has paid for itself in extra profits. Carrying this latter principle to a logical conclusion, it should be rated first at nothing, and gradually *appreciated* up to full price. All of this is, of course, working upon the safe side, as regards the danger of over-valuation, but it is difficult to see how a corporation, for instance, could account to its stockholders for the money which they paid in, if all the plant happened to be of this special nature. An inventory upon such a basis would also be rather an awkward document to show to would-be purchasers of the business who were to be assured of its prosperity.
>
> In practical dealings with this question, it seems to me that the best course is to give all special tools an inventory rating at their apparent value, and then to lay aside a portion of the extra profits which these tools have earned by their special usefulness, in the general reserve fund, or "Surplus," of the concern. They may thus be drawn upon, should any too sudden collapse in values take place.

In view of the large number of manufacturers making daily use of special tools, and the importance of the question of their value to most of them, one cannot feel other than surprised that there should be so great a diversity of opinion as to the manner of their treatment at the time of inventory. The conditions governing their valuation are as obvious as those which apply to standard plant, and, in most cases, they can be much more easily appraised. Both are measured in the same currency, the only difference being that the one should be taken at its commercial, or marketable, value, while the other must be reckoned on the basis of its value to the owner. Let us examine the question in detail.

I had occasion recently to design a set of tools for the lathe work on one of our radial drill columns. The outfit cost $172.80, and reduced the time eight hours. Machines of this size are selling at the rate of one hundred per year. Taking the workman's wages at

25 cents an hour, and general expense at 20 cents an hour, the saving per year aggregates $360.00. Now, what are these tools worth? To an outsider, nothing; to us, assuming that the present value of a special tool depends upon its earning possibilities, the particular equipment cited should be valued at $360 — $172.80 = $187.20, the first year, $360.00 the next, and the same figure thenceforward, provided the sales remain the same year after year, the matter of deterioration not being of sufficient moment to require consideration. But on this basis increased sales run the value of the tools to an extravagant figure; even on the present business it is beyond their original cost, which, of course, is debarred—the valuation being limited by the cost of making. They are certainly worth $172.80. To charge this amount to general expense would make it appear as a liability,—something that should be paid for immediately, as are consumable stores,—which it positively is not; yet we dare not charge it to standard plant, as we have no assurance of the length of time during which the tools will continue in use, and we know that they are valueless as second-hand plant. What, then, is to be done? There appears to be but one solution. They must be classed in a category by themselves, the value of which will represent assets—or nothing, according to the object of the inventory, which may be to determine their value either to the owner, or to a prospective buyer of the business, or to learn the amount by which the whole assets of the company must be decreased in a winding-up of the business.

The next question to be considered is the matter of their depreciation. This depends solely upon the extent of obsoleteness. They are worth their cost so long as the saving which will be effected through their *future* use is not less than that cost. That is to say, the tools will continue to be worth $172.80 until such time as they will be used but $172.80 — (8 × .45) = 48 times more. Granting that this logic is correct, we then have the following general rule, which, though perhaps especially applicable to jigs and fixtures, is, I think, sufficiently elastic to cover special plant of all kind:

Charge all non-perishable tools of an unusual and irregular nature to special plant at cost. Let their value remain at this figure until the saving in cost on the future probable output of said tools falls below their cost. Then depreciate, dollar for dollar, in accordance with the shrinkage that occurs from time to time in the total amount of saving that will be effected during the remaining term of their usefulness.

It now remains to consider only how, after the tools have been once appraised, they may be satisfactorily treated in the books of the company. Inventory-taking is, at best, a jading and perplexing

SPECIAL-PLANT LEDGER

TOOLS FOR No 1 RADIAL DRILL SYMBOL 6A

MARK	MADE			COST		TOTAL		1890		1891		1892		1893		1894		1895		1896		1897		1898		1899	
6A1				25																							
" 2				15				5																			
" 3				30		70																					
" 4	2	4	90	48	50																						
" 5	4	6	..	6	75																						
" 6	7	15	..	10	25	65	50			10	25																
" 7	1	3	91	8																							
" 8	3	7	..	5	50					1	50																
" 9	5	9	..	10	25	23	75																				
VALUATION IN JANUARY								70	00	130	50	142	50														
SHRINKAGE DURING YEAR								5	00	11	75																
VALUATION IN DECEMBER								65	00	118	75																

FIG. 2.

problem, and it is safe to affirm that, unless it can be shown that the labor incident to the successful working of a proposed system alleviates, to a greater or less extent, the irksomeness attending the prevailing practices, that system is very sure to be rejected.

In Fig. 2 is shown the method and style of book employed by the writer. In this ledger is kept an accurate record of all tools possessing more than a scrap-value, all of which are grouped with due regard to the kind and size of machine in the manufacture of which each is to be used. On old tools, of uncertain history, only the column headed "Cost" is filled in, while all new tools are entered in full, examples of both being shown in the illustration. The figures under "1890," and opposite "Valuation in January," show the inventory value in January, 1890, of all tools in use on the particular machine to which this page of the ledger is devoted. If, during that year, tool 6 A 2 is depreciated $5, this amount is entered under "1890" and opposite "6 A 2." At the end of the year this sum is subtracted from the January value of $70, leaving a remainder of $65. It will be seen, however, that three new tools (6 A 4, 6 A 5, and 6 A 6) have been added during the year, aggregating $65.50 in value, which, when added to the depreciated value of $65, for the old tools, gives $130.50 as the total valuation of all the tools at the commencement of 1891. In this year, tool 6 A 6 is written off entirely, and tool 6 A 8 depreciated $1.50, giving $118.75 plus $23.75, or $142.50, as the value of all tools in January, 1892. The book thus accomplishes nine distinct objects. It shows: (1) just what tools have been made for each machine; (2) the date when each was made; (3) what each cost; (4) the total valuation of the tools added each year; (5) the amounts by which each has been depreciated; (6) the year in which said depreciation was made; (7) the amount by which the full set has been depreciated; (8) the total valuation of all tools at the beginning of any year; (9) the total valuation of all tools at the close of any year.

Instead of having to go over, and revalue, from one to two thousand special tools every year, it is necessary only to note what tools have been rendered obsolete since the last inventory, the entries being made by the chief draughtsman at the time of making the alterations in the corresponding drawings and patterns which destroyed their usefulness. The prime cost book shows pretty closely what the tools are saving. Catastrophes, causing the demand for a standard machine to suddenly cease, are rare. Hence it is not difficult to determine the time when the future saving likely to be effected by an outfit of tools falls below their rated value. And, with this danger line clearly before him, there is little excuse for the manager who passes it.

THE FIELD FOR THE AUTOMATIC GAS METER.

By Edward A. Harman.

AS one of the minor phases of engineering, the rapid development of the penny-in-the-slot system which has astonished the millions demands something more than a passing notice. One of the adaptations which is most serviceable—and most surprising in its apparent failure as yet to obtain in the United States a foothold at all comparable to that which it it has found in Great Britain —is that for gas distribution. Possibly the enormous success of this system is due mainly to the reasonable desire of the public to know what they are buying, to the cash payment, and to the immense popularity of the pennyworth.

With the slot meter the lessening of the light constitutes a gentle reminder that a definite quantity of gas has been used. Possibly it is the absence of any such check or hint in the case of ordinary consumers that leads to dissatisfaction when the account is presented. In cases where a slot meter has materially increased the consumption, by the facility afforded through the medium of the cooker, there cannot arise any dissatisfaction with the amount. The consumer knows at the time the reason of the increase, whereas, ordinarily, months elapse, and he may be unable to recollect the cases of illness or other exceptional circumstances which caused an increase of consumption.

It has occurred to the writer that an automatic arrangement might be attached to ordinary meters to check the consumption at intervals of 1,000 or 10,000 cubic feet of gas, thus reminding the consumer of his rate of consumption. But in most cases such an arrangement would probably be a nuisance.

To such a state of perfection have automatic gas meters been brought that is is impossible to foresee how far they will be ultimately extended. It is probable that in the near future the managers of different rooms, workshops, offices, etc., in the same institution, will control the consumption of what is required for lighting and heating purposes by automatic interception meters, rather than allow an indefinite quantity of gas to be used, without regard to cost, as the general custom is now. Such waste affects not only the cost of production of materials, but also the health of the workers, which is of the first importance. It may be found advantageous, where rooms are let as apartments in houses or hotels, to make each tenant responsible for his own consumption of gas, in preference to the unsatisfactory fixed charges so generally made in England and on the continent. For internal arrangements in workshops slot meters might be employed, by a mutual arrangement with the head of the department and the employees. Of course the meter would be the property of those directly concerned. The meters, being fixed in a passage or landing, could easily be made accessible for examination and for collection at suitable intervals. In cases of illness the ready check afforded upon the consumption of a bedroom stove is a satisfactory feature.

Applications for automatic meters are so numerous that few British gas undertakings can afford to ignore them—especially in view of their effect in increasing consumption of gas. They increase revenues not directly only, but indirectly, by popularizing gas in every home, office, or workshop. It has recently been pointed out that for city and town offices a gas fire is perhaps as advantageous a method of heating as can be used, no attention being required from the time the stove is lighted in the morning until the gas is turned off at night, except to raise or lower the flame in accordance with the demand for heat. For bedrooms, gas fires are growing in popularity. Where connected directly with the chimney by a flue, this method of heating is peculiarly suitable. The temperature of a room can be maintained evenly night and day, which in case of illness is of great importance, while the dirt, bustle, and disturbance of the patient involved in making a fire are dispensed with. Moreover, heat is always available,—an advantage which those affected with asthmatical, bronchial, or kindred complaints cannot afford to disregard, in view of the liability to sudden attack in the middle of the night, when hours must elapse before a coal fire can be made.

Many gas undertakings are now recognising the importance of supplying apparatus for gas fires, fitting free of cost, and making only a nominal annual charge for the stove. The undertaking of which the writer is the engineer is doing this with good results. In consequence of what has come to be known as the "Fixed Free" stove business, numerous stove and meter makers have been inundated with orders, the delays thus occasioned being vexing alike to the consumer and the gas officials. The method of calculating the desirability of adopting the penny-in-the slot system is simple. The writer's experience is that, for an ordinary automatic meter for lighting purposes only, the annual gas-consumption is 10,000 cubic feet; where a small cooker is supplied, the consumption is doubled. This quantity of gas, at the profit on cost of manufacture, will furnish an income equal to interest on the small original outlay, depreciation, and extra cost of collection. From twenty to thirty-five cubic feet of gas for a penny is the general charge. In the United States, where gas at one dollar per 1,000 cubic feet is considered cheap and lower rates are not often afforded to the consumer, even in large cities, the price will probably seem very small. On the side of the gas undertaking, however, is the certainty and simplicity of collection and the dispensing with all the office labour connected with recording meter readings, keeping a multitude of small individual accounts, and dealing with a multitude of small complaints.

An ordinary flat-flame burner consuming five feet per hour will last from four to seven hours on the expenditure of a penny ; where an incandescent burner is used, consuming from three to four cubic feet per hour, the pennyworth will last proportionately longer. Generally speaking, gas undertakings in Great Britain supply fittings, burners, meter, and stove free of cost, so that the consumer's maximum liability is only one penny. The addition of a small cooking stove is as great a convenience comparatively in small class property as in large, where gas cooking-stoves are considered well-nigh indispensable.

A development which has been so productive of satisfaction to the gas undertakings and to the consumer, so far as it has been followed, deserves the attention and study of engineers and managers, with a view to extending its benefits where it is known, and establishing it in places where, although an innovation, its introduction seems likely to be attended by similar success.

A REVIEW OF THE NICARAGUA CANAL SCHEME.

By W. Henry Hunter.

THE project for the construction of a maritime canal on the Nicaraguan line resembles its rival of Panama, in that it is the modern outcome of a lengthened history.

The years 1850–52 form an important landmark in the narrative, for in those years, and at the instance of the Transit Company (in whose hands the whole of the trans-isthmian trade—such as it was—then lay), Col. O. M. Childs, a canal engineer of special ability and experience, made the first engineering survey of the Nicaragua route ever executed, which, although necessarily meagre and incomplete, has formed the basis of all which has since been done in connection with that route.*

Col. Childs submitted a report and a proposal for a waterway with a ruling depth of seventeen feet, which appears, so far as it went, to have been of a workmanlike character, and suitable for the requirements of fifty years ago, the weakness in the scheme being due to the inefficient design of the harbour at Brito, which formed the Pacific terminus of the undertaking. This weakness was, in some degree, recognised by Childs himself, who, with refreshing *naiveté*, deprecated criticism of the design, on the ground that he was a canal engineer, and inexperienced in the construction of harbours. A much more serious weakness, then latent, since developed, lay in the decaying condition of the Atlantic terminus, the harbour at Greytown, which, in Childs's time, was still commodious and convenient, but in which, since his time, deterioration has ended in destruction.

The year 1872 furnished the next stage in the story, when the United States government despatched a party under the charge of Commander Lull, U. S. N., to examine further the route proposed by Col. Childs, and to obtain, in addition, such information, topographical, physical, etc., as was practicable in the time at the disposal of the expedition. Commander Lull presented his report in December, 1873. He recommended that the Childs project be enlarged, that the ruling depth of the canal be increased to twenty-six feet, that the locks be made longer and wider, and that certain modifications be made in the positions of the locks and dams.

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* The Editors hoped to present, with this paper, a series of illustrations which should show the progress of work on the Nicaragua canal as accurately as the progress of the Panama enterprise was exhibited, by photo-engravings, last month.

Two fatal obstacles were interposed. First, the actual work done, as summed up by Mr. Hunter on the opposite page, is too small to supply many subjects for illustration of canal construction; second, the Maritime Canal Company decline to supply any photographs except for use in connection with an article which has their approval. Mr. Hunter's view point, being the same as that of the Ludlow commission, is not pleasing to them. The photographs presented show the general topography of the country traversed.

Among the gentlemen who formed the Lull expedition was Mr. A. G. Menocal, who had just entered the government service as a civil engineer attached to the United States navy. Under the direction of the government Mr. Menocal revisited Nicaragua in 1880, and again in 1885, carrying out at each visit further geodetical operations and reporting to the government in 1885. Mr. Menocal suggested important modifications in the Childs project as amended by Lull, which, with others introduced from time to time since the date of the report, are practically all embodied in the scheme now presented by the Nicaragua Canal Company; it is, therefore, unnecessary to describe or discuss them at this point.

Shortly after the publication of Mr. Menocal's report, and through his agency, a concession was obtained from the government of Nicaragua for the construction of a canal within the Nicaraguan territory, and on the line proposed by Mr. Menocal. The concession provided, *inter alia*, that the final plans of the canal should be deposited, and that the work should be begun in earnest, within a period of two and one-half years from the date of signature. The Nicaragua Canal Construction Company therefore was formed, the concession was transferred to it, some money was raised, and arrangements were made for the commencement of preliminary operations at the terminus of the canal on the Atlantic seaboard.

In 1889 the Maritime Canal Company was formed under a special charter from the United States legislature, and the concession was transferred once more,—this time from the Construction Company to the Maritime Company, arrangements being made, somewhat difficult for outsiders to follow, by which the work was still proceeded with by the Construction Company. That the arrangements were not without their advantages became apparent in 1893, for in that year the Construction Company went into liquidation, leaving the position of the Maritime Company intact.

Since 1893 the financial situation has, in the words of the present president of the Construction Company, "been bad." It has been difficult to obtain money, and but little work has been executed. Prior to that date, a length of one thousand feet of pier-work had been constructed at Greytown, a channel had been dredged on the foreshore, and some three-quarters of a mile of the canal had been formed by dredging in the low, swampy ground. A single line of railway had also been formed across the lagoon, from Greytown to the site of the first lock, the length of the line being about eleven and one-half miles. These works, with the addition of certain telegraph lines, represent the sum total of the efforts which have been made to construct a waterway on the Nicaraguan line.

The project which the Construction Company thus commenced to carry out was one which was described in a report by Mr. Menocal, and which was submitted to the company in 1890. The report was adopted, and the project accepted by the company as its own.

Before describing the project in any detail, another important event in the history of the scheme should be noted. In 1895, following upon the passage through the legislature of an act to amend the Maritime Company's act of 1889, and under special statutory powers, a board of engineers was appointed by President Cleveland "for the purpose of ascertaining the feasibility, permanence, and cost of construction and completion of the Nicaragua Canal," as proposed by the company. The board was composed of three members, each of whom was a distinguished engineer of special experience and of absolute impartiality, the names of the members being Col. Ludlow, U. S. A., Mr. Endicott, U. S. N., and Mr. Noble, a civil engineer specially experienced in canal construction.

These gentlemen spent six months in a careful study of the Canal Company's project, going over the route in Nicaragua and examining the drawings and documents in New York. They presented their report on October 31, 1895. The report was not regarded by the Canal Company as a satisfactory document, and, since its publication, the representatives of the company have met the conclusions arrived at and the recommendations made by criticisms couched in terms of such asperity as almost to border upon acrimony.

Notwithstanding these efforts (natural enough under the circumstances) to weaken the force of the report, it still remains the one authoritative pronouncement by an impartial tribunal upon the proposal of the Nicaragua Canal Company, or, to speak more accurately, it did remain as such until a very recent period, when the second commission appointed by the United States government, and presided over by Admiral Walker, presented a report which, from the abstract presented, seems to emphasize the value of the opinions expressed by Col. Ludlow* and his associates.

In the following effort to describe the Nicaragua Canal project as developed by the company, the views and recommendations of the Ludlow board will, so far as is practicable, be considered together with the details of the company's scheme.

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*The place occupied by Col. (now General) Ludlow in the confidence and esteem of his fellow-citizens may be gathered from the fact that he has recently been appointed to fill the difficult and responsible post of governor of Havana.

The termini of the proposed waterway have been located, respectively, at San Juan del Norte, or Greytown, as it is more commonly called, on the Atlantic, and at Brito on the Pacific. A line joining these two points would lie but a few points off due east and west, the distance between them being about 140 miles as the crow flies. The same distance measured on the line of the waterway is given by the Canal Company as 169.4 miles, but even this elementary figure has been adversely criticised by the board, which considers it to be 4.5 miles too short, in which case the total length is about 174 miles.

PRIMITIVE NAVIGATION ON CENTRAL AMERICAN WATERS.

The special feature of the Nicaragua route is the great inland sea which lies in the hollow between the eastern and western Cordilleras, and which is known as Lake Nicaragua. It has a length of 110 miles, an average width of 40 miles, and an area of about 2,600 square miles, the mean level of the surface being 110 feet above the sea. This great lake divides the projected waterway into three sections, as follows:

1	From Greytown to the easterly side of the lake,	100.40 miles.
2.	Across the lake,	56.50 "
3.	From the easterly side of the lake to Brito,	17.25 "

The special feature of the company's scheme for the waterway,

THE HARBOR AT PORT LIMON.

and that which differentiates it from its predecessors on the same line, is the proposal for the extension of the summit level—the level of Lake Nicaragua—both to the eastward and to the westward by the formation of two huge dams,—on the one hand, at Ochoa on the Rio San Juan, at a site below the confluence of the San Juan with its greatest tributary,—the San Carlos, and, on the other hand, at La Flor, in the basin of a small stream called the Rio Tola. The summit level would be so extended through the construction of these dams as to cover a length of about 149 miles out of the total length of 174 miles, —that is to say, a vessel passing through the Nicaragua Canal would traverse a section of nearly 150 miles in length without any lock.

Taking Greytown on the Caribbean sea as the starting-point of a description of the details of the company's scheme, the most formidable difficulty which lies in the way of the achievement and of the successful working of the project is met with at the very threshold. Greytown lies in a re-entrant angle formed by the delta of the San Juan, and on a lagoon which was once a harbour, the mouths of the river which form the present channels of discharge for its waters lying to the eastward and southward of the lagoon.

VOLCANO OF MONOTOMBO, NEAR LAKE MANAGUA, NICARAGUA.

The reason for what, in the language of theology, would be termed the perversion of the harbour has been the subject of much discussion, although the leading physical features to which the perversion has been due, and as to which all are agreed, are fairly well defined. First, the San Juan drains an area of more than 15,600 square miles. The rainfall in the watershed is enormous, the maximum being on the Atlantic coast line, where it reaches the prodigious figure of three hundred inches per annum ! From that coast-line the rainfall diminishes sensibly in the direction of the Pacific, but is still extraordinarily great over the whole watershed. Then the basin of which Lake Nicaragua is the centre, and to which the San Juan furnishes the outlet, has been subjected for unknown ages to volcanic disturbance, and is still dotted over with cones and craters. This volcanic activity (now well-nigh outworn) furnished an unlimited supply of material for transport to the sea, while the rushing rivers, themselves the products of the torrential rainfall, furnished the transporting power required.

The swamps on the fringe of the Caribbean, through which the mouths of the San Juan have been formed, bear witness to the potency of these mighty volcanic and climatic forces, for, through their effects, the coast line has been thrust back from the low hills, whose feet were once laved by the ebbing and flowing tides, but which are now divided from the ocean by some ten or twelve miles of intervening land, swampy land, formed of the *débris* from the hills and the upland vallies, and from the igneous dust emitted by the sobbing craters and brought down by the burdened streams.

The distance between the hills and the coast line would have been greater than it is, but, as the river thrust the delta further and further into the sea, the coast winds, constantly varying in force, but within certain limits nearly steady in direction, have acted, and still do act, on the coast line, striking it at an angle, causing ceaseless wave action and consequent attrition, and re-disposing the eroded material along the coast in a more regular and even way than that in which it was first deposited.

As a result of all this, there is a constant trend of material towards the re-entrance angle in which Greytown is situated, with the further result that the one-time safe and commodious harbour was first shoaled and then obliterated, the fact being that the angle is being filled up, slowly, but surely.

The policy which fights against the forces of nature is a mistaken one; it is foredoomed to failure. Nature may be aided in her operations; her more gigantic forces may to some extent be curbed and controlled; but an almost certain Nemesis pursues any effort which may be made to arrest and to determine in an absolute way a process so continuous as that of the filling up of the Greytown bight.

Having in view the facts of the case as to Greytown, and having, after close investigation, arrived at the conclusion that the destruction of the harbour there *was* due to a continued effort of nature, the board recommended that the efforts which had been made to commence the construction of the canal at that point should be abandoned, and that the entrance should be moved some distance to the eastward. The recommendation has been met on the part of the representatives of the Canal Company by stout resistance, their principal objection being that the change would involve the transfer of the terminus from the territory of Nicaragua to that of the neighboring State of Costa Rica, and that the transfer would not be agreeable to the Nicaraguan government and might imperil the concession.

The word "government" is of elastic significance. It has one meaning when used in relation to a civilized and powerful State, and quite another when used in relation to an Isthmian republic.

Difficulties raised by a government of this class should not be insuperable, nor can objections based on the apprehension of such difficulties be regarded as weighty. Nevertheless the difficulties are maintained by the Canal Company; they decline to abandon their infant works at Greytown, and adhere to that point as the terminus of their scheme. No person who has had practical acquaintance with the difficulty of keeping open a navigable channel across a sandy foreshore will doubt that, if a channel of the required depth can ever be formed at Greytown, such channel would be filled up whenever strong winds from the east or northeast might prevail for any time, and silted up to such an extent as to effectively block the traffic (except perhaps in the case of small vessels of light draught) for weeks together, even in the face of the most desperate efforts, which would undoubtedly be put forth for its removal by a frantic administration.

A CENTRAL AMERICAN FOREST.

From Greytown the course of the canal will pass through low, swampy lands and stagnant lagoons, till the rising ground which is to form the site of the first lock is struck. The length, measured on the line of the canal, is already ten miles: it is not anticipated that any constructive difficulties will be encountered in this length. Lock No. 1 is to have a lift of 31 feet from mean sea-level; and, in conjunction with it, a series of small embankments are to be constructed, so as to close the gaps in the hills and form a basin above the lock. Through this basin a channel is to be carried to the second lock, the work required being merely excavation and dredging. Lock No. 2 is to be placed at a distance of 1.25 miles from Lock No. 1, and is to have a lift of 35 feet; a second basin is to be formed above Lock No. 2, with a channel of a length of 1.95 miles to the third lock. A heavy dam and another series of embankments will be required to impound the waters in the second basin. At Lock No. 3 the summit level—provided the anticipation of the promoters be realised—will be attained by a lift of 40 feet. It is necessary to insert the proviso, as a serious discrepancy exists between the anticipations of the advisers of the company and those of the board. Further reference will be made to this discrepancy. It is sufficient here to say that, in the view of the board, the lift at Lock No. 3 will be 44 feet.

A third basin is to be formed above Lock No. 3 by means of a third series of embankments. Through this basin the navigation will be carried for about three miles, where the spur of the Cordilleras, which forms the "eastern divide"—that between the Caribbean and Lake Nicaragua—will be reached. A favourable location for the line of the canal has been found through the spur; yet the cutting required will be of sufficiently formidable dimensions, as the length will be 2.90 miles, the maximum depth 328 feet, and the mean depth 141 feet.

The possibilities of disaster in a cut of these dimensions are almost infinite, and the most searching and complete investigation is required before even an approximate estimate of the cost of carrying it into execution can be made. The board complains that no such investigation has been made, and points out that the borings which the company did make showed "rock more or less decomposed" at great depths below the surface, "which may crush and cause the sounder rock above to fall." This ominous fact appears to have been overlooked or ignored by the company.

It is proposed that the bottom width of the canal in the cutting through the eastern divide should be reduced to 100 feet, the bottom width of the channels at either side being 120 feet. After leaving this cutting, the course of the canal is to be carried through four basins, which are to be formed in the San Francisco and adjoining valleys, and are to be connected by three cuttings of moderate depth, the aggregate length being 3.5 miles. A further series of dams and embankments, some of which will be huge, perilous, and costly work, will be required to enclose these basins.

It is claimed that* "several important advantages are gained by this treatment," the first being an obviously substantial saving in the cost of excavation. The claim proceeds: "The economy, however, is not confined to the saving in excavation, against which, of course, must be charged the cost of the embankments, but is principally in the enormous saving in the deep rock excavation following, and in the valley of the Deseado beyond, by carrying the summit level through into the valley of the stream. The increased cost to result from a plan contemplating a much lower level would have been so great as to seriously handicap the undertaking financially." It is further claimed that the gain in navigation facilities and in maintenance are important, and that the drainage operations will be assisted by the high-level scheme.

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* "The Nicaragua Canal," by A. G. Menocal. Paper read at the World's Water Congress, 1893.

There is a grave doubt as to whether the advantages to be gained by the treatment proposed are commensurate with the almost incalculable cost of the works, the risks of construction, and the uncertainties of maintenance, involved in the formation of dams 80 to 85 feet in height from the level of the ground, upon sites in which the borings revealed that a depth of thirty feet of soft mud must be passed through before anything in the nature of firm soil can be reached, and in a climate in which "rainfalls of nine inches in nine hours, and of three in a single hour," are experienced.

The original intention was to form these dams to such a height as to enable their crests to be employed as waste weirs for drainage purposes. Had this intention been carried into practice, disaster would have been not only courted, but constrained. More prudent counsels have prevailed, however, and the present intention is that the dams should be raised above the highest water level, and that the drainage should be provided for by sluices, to be placed in the solid ground, at a low level, and adjacent to the site of each dam.

A SAMPLE OF RAILWAY CONSTRUCTION, SAN JOSE.

These sluices, together with other works, have been provided "to meet possible contingencies, specially in the series of embankments in the San Francisco ridge, which, it is frankly admitted, is the weakest feature in the whole route."*

At the westerly extremity of the uppermost of the three cuttings by which the basins in the San Francisco ridge are to be connected, the course of the river San Juan itself will be struck. It is intended that the course of the San Juan should be utilized for navigation for the whole distance between the uppermost cutting and Lake Nicaragua,—a length, according to the company, of 64.5 miles, or, according to the board's correction of the company's figures, 69 miles.

To permit of the utilization, the level of the San Juan, and of its great tributary, the San Carlos (the confluence of the two streams takes place at a point about four miles further up the course of the San Juan), must be raised to the level of Lake Nicaragua. In order to achieve this, the formation of another huge dam is projected, the location being at Ochoa in the San Juan valley. The design for this dam is said to have "been for years the subject of long study and careful consideration." Unfortunately the ground at the site which had been selected is of the most unfavourable character for the foundation of such a work, the central borings having been carried to a depth of twenty-five feet below the bottom of the river, without reaching any material more satisfactory than drift sand. The central borings were abandoned at the depth stated, so that the depth at which a solid foundation might be found is unknown; while the side borings—*i. e.*, those on the flanking hills—showed that thick beds of clay overlay the rock. Owing to the foundation difficulty, all idea of constructing a dam of the solid character usual in cases where consequences so momentous would follow a failure was abandoned, and a proposal which is considered "to embody simplicity, economy, and safety" was adopted. The proposal is to dump "from an aerial suspension conveyor large and small material properly assorted, across the river, from bank to bank, until a barrier is created sufficiently high and strong to arrest the flow and hold the waters at the desired level." It is not intended that the dam should be water-tight, it being assumed that the flow of the San Juan will, in the driest season, be ten times as great as the quantity of water which will be required for lockage and other traffic purposes, and consequently that 90 per cent. of the flow may be permitted to discharge itself *through the dam.* (The board entirely disagrees with the assumption as to the minimum flow of the San Juan.) It is further intended that, in addition to the use of the dam as a filter of a singularly coarse type, the crest thereof should be employed as a waste weir, discharging a considerable proportion of the immense floods of the San Juan.

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* Mr. Menocal's paper to the World's Water Congress.

The principles of static resistance to dynamic stress are now fairly well understood in the engineering world. The application of these principles to the case of the proposed Ochoa dam has, briefly stated, the following results: (1) the frictional resistance to sliding or rolling, one over the other, of the component parts of the dam, is to be destroyed by invited percolation; (2) an impelling force of kinetic energy is to be induced to act upon the dam, in the manner in which that energy will be most effective; (3) an equation of the forces of resistance and destruction will be established, which will take the form of a somewhat extended line of *débris* over a considerable part of the valley of the San Juan. It is hardly necessary to add that the proposal has provoked almost unanimously adverse criticism, since it was first announced; yet it is gallantly maintained by its author. It is a modern instance of *Athanasius contra mundi.*

A ROAD IN THE CENTRAL AMERICAN CORDILLERAS.

The company proposes that the crest of the dam should be formed at a level of 105 feet above the sea. It intends that the summit level of the lake shall be 110 feet, and, as it anticipates that a fall of three fourths of an inch to the mile will be found to exist, even in dry seasons, over the whole surface of the San Juan for the 64½ miles (as they reckon the distance) which intervene between the lake and the site of the dam, it proposes to provide for the fall of 4 feet and for the overflow depth on the crest by lowering that crest 5 feet, thus arriving at the proposed level of 105 feet.

Herein is the discrepancy between the anticipations of the company and those of the board, to which reference has already been made. The board is of opinion (and most practical men will agree with them) that the dry-weather flow from the lake has been seriously over estimated, and that, in view of the true quantity of water passing and the great sectional area of the canalized river, the surface inclination of the river will be practically *nil*, as the river will become but a prolongation of the lake. This important question sensibly affects the estimates of the cost of construction.

But few words are required to describe the proposed course of the navigation between Ochoa and Lake Nicaragua. The work in rendering the San Juan, as raised and canalized, suitable for navigation purposes being of an ordinary character. No question of en-

A NATIVE HOUSE, COSTA RICA.

VENGANZA BRIDGE, ATLANTIC RAILWAY.

gineering practicability, either as to construction or maintenance, will arise. The questions are only as to cost and time. The company proposes that the bottom width of the channel shall be 125 feet, which appears to be sufficient, except at the curves ; the board recommends 250 feet as the width.

The proposal for the formation of the channel across Lake Nicaragua also admits of great brevity of review. On the navigation line the lake measures about 56½ miles from side to side ; to form the channel, some 14 miles of dredging through soft mud will be required on the westerly side, while on the easterly shore a rocky ledge of 400 yards in width will be met with, through which the course of the canal is to be carried by means of blasting and dredging. Two short protecting piers are also to be constructed at the easterly junction of canal and lake. The course of the canal will strike the lake at the point where the river San Juan flows out from the lake, and will leave the inland sea at the point of inflow of the river Lajas. The length of that course from the mouth of the Lajas to the Pacific terminus will be a little more than 17 miles ; of this length some 9 miles, measured from the mouth of the Lajas, will be in continuous cutting, the "western divide" being reached at 4.70 miles from the commencement of the cutting. Even through the "divide" the depth of the cutting will be moderate,—73 feet,—the point of intersection being, in the words of the company, "the lowest in the mountain chain which extends from the Arctic ocean to the straits of Magellan." The excavation will be mainly in rock, and it is intended that through the deeper part the bottom width shall be 100 feet, the width on either side being 125 feet. The western extremity of the cutting will debouch upon the valley of the Rio Grande, which, with the adjoining valley of the Tola, is to be converted into a huge basin by another great dam, to be formed at a place known as La Flor, where the fourth and fifth locks are also to be built. La Flor is about fourteen miles from the western shore of Lake Nicaragua, measured (like the other distances referred to in the foregoing) along the course of the canal.

Looked at upon the surface, the site of the proposed dam appears to be most favourable, as the valley is constricted and the flanking hills are high. Unfortunately the difficulty as to foundations, which is in-inherent to almost the whole of the route proposed for the canal, becomes particularly acute at La Flor. Borings made on the line of the dam showed that no less than 100 feet of very soft material would have to be passed through before the rock could be reached and a foundation obtained. Originally it was proposed that a "rock fill" dam, similar to that suggested for Ochoa, should be dumped in at La Flor, but the design has been modified,—very prudently; and it is now intended that a solid core of concrete, founded upon the rock, shall be formed, and shall be reinforced by earthworks, on either side. Properly proportioned and executed in a workmanlike manner, this would form a satisfactory and reliable dam, and one upon which the safety of a great waterway might be allowed to depend; but it is desirable that the estimate of its cost should be made or revised by some person who has already carried out a similar work, while the manner of construction proposed for it throws the remarkable character of the design for Ochoa into even stronger relief.

Locks 4 and 5 will have a combined fall of 85 feet,—*i. e.*, from the summit level 110 feet to 25 feet above sea level.

From these locks the course of the canal will traverse the valley of Brito, in which, and at a distance of 1.58 miles from Lock No. 5, Lock No. 6, the last on the route, is to be constructed. As the Pacific has a tidal rise of 8 feet at Brito, the fall at Lock No. 6 will be variable, 29 feet being the greatest fall and 21 feet the least. From this lock to the Pacific foreshore a channel of nearly a mile and a quarter in length will be formed; the work will be confronted by no special difficulties, and calls for no special remark here.

In the paper which was presented to the Chicago Congress of 1893 by the chief engineer to the company—to which reference has already been made—it was stated that "the only well-founded criticism to the Nicaragua route of an inter-oceanic canal is the lack of good harbours." Strict literary accuracy might take exception to the statement, having regard to another statement in the same paper (quoted *in ante*) that "the series of embankments in the San Francisco ridge . . . is *the weakest feature in the whole route*," and might well argue that, if, in the case of the harbours (or want of harbours) where the weakness appears to be regarded as but comparatively great, criticism of the company's project is admitted to be "well founded," criticism of a feature whose weakness is the subject of superlative description may claim to have an even more substantial basis.

A RAILROAD CUT IN EARTH AT LA JUNTA.
Showing the steep earth slopes.

Be this as it may, there can be no doubt that the want of terminal harbours is the overwhelming difficulty which would have to be encountered, if a serious effort were made to construct and work the waterway on the Nicaragua line, as now proposed.

Brito is not as bad as Greytown, but Brito is bad enough. There the board found, even in the calmest weather, "a nearly constant

HEAVY GRADE ON THE FERRO CARRIL DE COSTA RICA.
Showing the steep earth banks.

surf, with breakers from 4 to 10 feet and over in height." Storms are said to be rare, which is fortunate, as their effect upon a practically unsheltered coast, with a "fetch" of many thousands of miles behind, must be simply irresistible.

The harbour question may, therefore, be readily epitomized. On the one hand, the terminus at Greytown would always be subject to the risk of obliteration by the Atlantic waves: on the other, the terminus at Brito would ever be liable to destruction from the roll of the Pacific breakers.

The estimate of the cost of construction published by the company is $65,000,000. A board of engineers reviewed these figures on behalf of the company, and increased them to $88,000,000. Including the sum required for payment of interest out of capital during construction, the gross estimate becomes $100,000,000.

The Ludlow board expressed a halting hope that the sum of $133,000,000 might be found sufficient for the actual construction. It is reported that the Walker commission has ventured upon an estimate of $124,000,000 for the same cost.

Festina lente is the classic form of the good old Saxon proverb, "The more haste, the less speed." There are few enterprises to which the proverb does not apply, and none to which its application is of more cogent importance than that for the construction of the inter-oceanic canal. Advancing civilisation, bringing in its train the increasing requirements of a multiplying population, demands that the Central American isthmus should no longer be permitted to act as a barrier to the circulation of trade. The manner of the severance and the route which should be followed are still matters of debate, constituting a question to which no authoritative answer has been given.

The people of the United States form the principal factor upon which the settlement must depend, and it is to the United States, as a nation, that the world must look for the assurance that the settlement is the best possible, and that, when the pronouncement in favour of one route or the other is made, it shall be free from the influence of passion and from the taint of prejudice.

There is but one method by which the people of the United States can discharge this national duty and attain the object which is ad-

SOME OF THE PRODUCTS OF THE COUNTRY.

mittedly to be desired. That is the constitution and appointment of a competent tribunal,—a tribunal composed of men who enjoy the confidence and esteem of all that is best and most worthy in the civilised world, and whose judgment would command general acceptance. Before this tribunal let the advocates of both routes—Panama and Nicaragua—appear by counsel and present their respective schemes, supporting the project by such scientific testimony as they can produce. Let, above all things, the evidence adduced on each side be tested by competent, and therefore searching, cross-examination.* Let the enquiry be of the most public kind; let all the proceedings take place in the blaze of a light as fierce as that which is said to beat "upon the throne"; and let the decision be accepted as final by the world.

There is a disposition on the part of certain persons to attempt to rush the Nicaragua Canal project through at the present moment. High ground is being taken by these persons, patriotism is invoked, self-interest is called into play, and other efforts are being made to excite feeling, whether of a worthy or of an unworthy character. The question is too great to be settled in this manner. The American nation is but beginning to take its true place among the families of the earth; it is like the sun, rising in strength and rejoicing in the race which is set before it, and which it is just commencing to run. Paltriness of object and littleness of vision would stultify the nation at this time; petty selfishness would blight its growth. This canal question presents an opportunity to the people of the United States in which they can show that they appreciate their great place and their high position, and show it by assisting to settle the question in such a manner as will be for the benefit of humanity and for the advantage of the world. That manner will involve selection of the best possible route and of the best possible proposal,† and under present circumstances no convincing decision can be given in which such selection can be embodied, except by a tribunal of the character above indicated, sitting under circumstances such as we have ventured to recommend. America's true interest would be served by this, and all would agree to entrust the waterway constructed under America's auspices to America's trustee-like custody.

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* The necessity for cross-examination will become abundantly clear to any expert who peruses the report of the proceedings when "House Bill 35 (on the Nicaragua Canal)" was before the committee on interstate and foreign commerce of the house of representatives in Washington, in 1896.

† Present reports are that the estimates of individual members of the Walker board vary from $90,000,000 to $140,000,000. Mr. Hunter himself says:

"Having in view the lack of necessary information, and the enormous risk which will attend upon the operations necessary for construction, experience leads to the conclusion that, if any body of undertakers were able to carry through the works and open the canal to the trade of the world at an inclusive cost of $200,000,000, these gentlemen might well congratulate themselves upon their astonishing good fortune."

ELECTRICITY AT THE PARIS EXPOSITION OF 1900.

By Georges Dary.

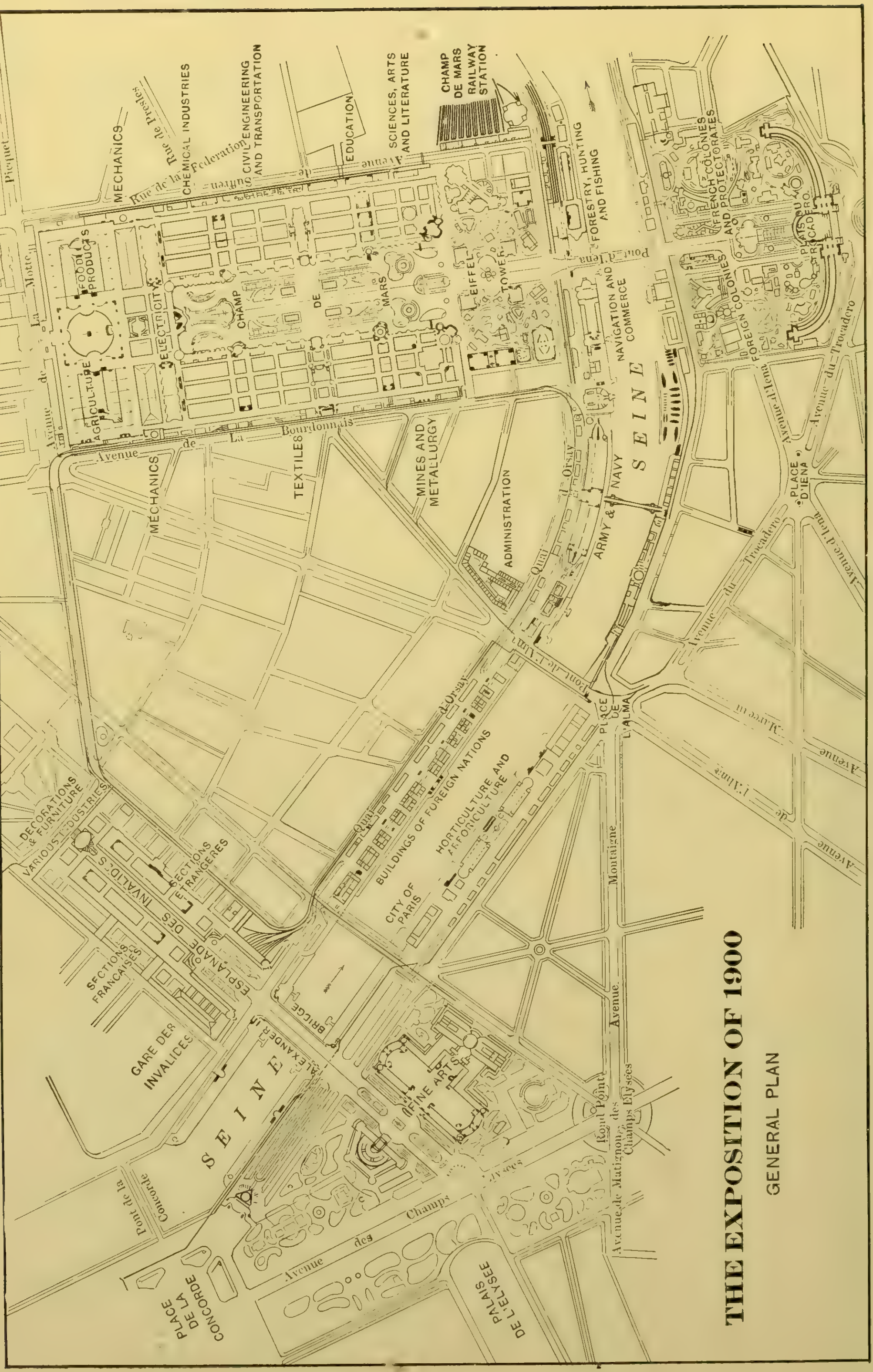
PARIS is everywhere in a state of upheaval—a prey to the fever of work. On every side, digging and building are in progress—embankments arising, trenches and foundation walls extending in regular lines, pillars towering, trusses stretching overhead, and scaffoldings raising their complicated tangle.

By train and by wagon, *débris* and structural materials are borne hither and thither; the noises of saws and hammers, the sharp whistling of cranes and locomotives, the cadenced cry of workmen handling heavy masses, rise in a strange mingling—it is chaos!

And this air of the workshop—of the hive in full activity—extends throughout the Champ de Mars, the Champs Elysées, the banks of the Seine, the Esplanade des Invalides, and the Montparnasse station—along the line of the belt railway, over the Metropolitan—to the Gare des Invalides, to the Gare d'Orléans, the Quai d'Orsay, in fact, everywhere.

For Paris would have everything ready that, fourteen months hence, she may receive worthily her many illustrious guests. In maintenance of her fame as a city of hospitality, she works day and night that she may, in May, 1900, welcome the world to an international reunion expresssive of the productiveness of industry and invention—the seal of the friendship which should lastingly unite the industrial peoples, and the dawn of a new era of peaceful labour.

When we recall the exposition of 1867, and the small space it occupied in the buildings of the Champs Elysées, we can gain an idea of the immense progress made by science and industry since a date so relatively recent even as that. The stages of this progress are clearly defined by the successive enlargements of the Paris expositions of 1878 and 1889. In 1878 the Champ de Mars and the Trocadéro scarcely sufficed; eleven years afterward the Exposition had extended over the left bank of the Seine and begun to encroach upon the Esplanade des Invalides. Still another lapse of eleven years, and that immense area no longer suffices; to the Champ de Mars, the Trocadero, and the Invalides must be added a large part of the Champs Elysées. The old Palais d'Industrie is superannuated; it must be torn down, and in its stead two gigantic buildings erected for 1900—one of them a marvel of architectural taste.

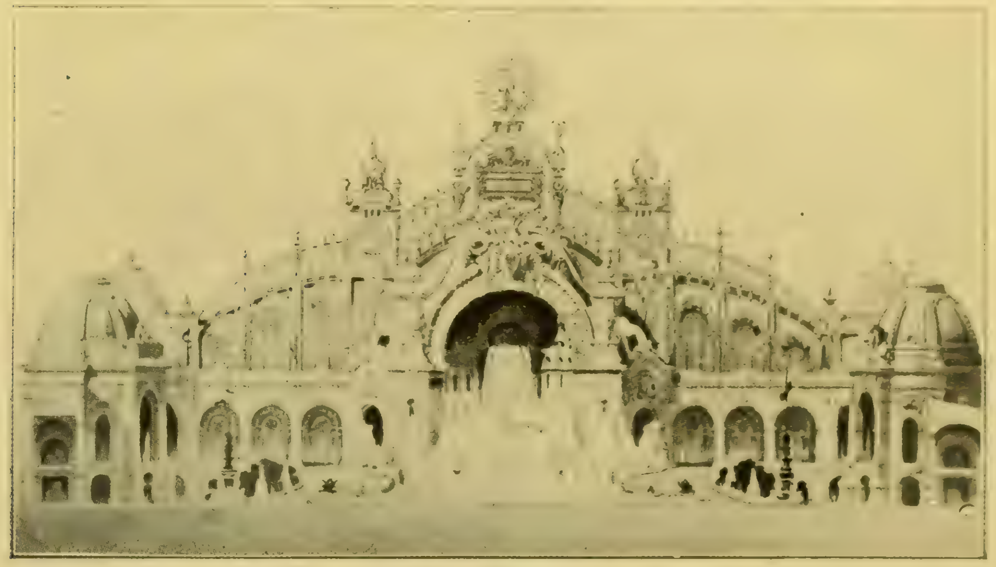


THE EXPOSITION OF 1900

GENERAL PLAN

Further, after having thus invaded the Champs Elysées, the Exposition stretches yet beyond, along both banks of the Seine, which are widened by solid masses of piling, and the narrowed river will flow, in 1900, between two ranks of splendid buildings from the Pont de la Concorde to the Pont Mirabeau, near the fortifications.

The Machinery Hall, with the Eiffel Tower, will be the only vestiges of the Exposition of 1889 remaining in 1900; and even the machinery building will be transformed, since it is designed to shelter an entertainment hall of 6,300 square metres, capable of containing 25,000 spectators, while its two ends will be devoted to agricultural and food displays.



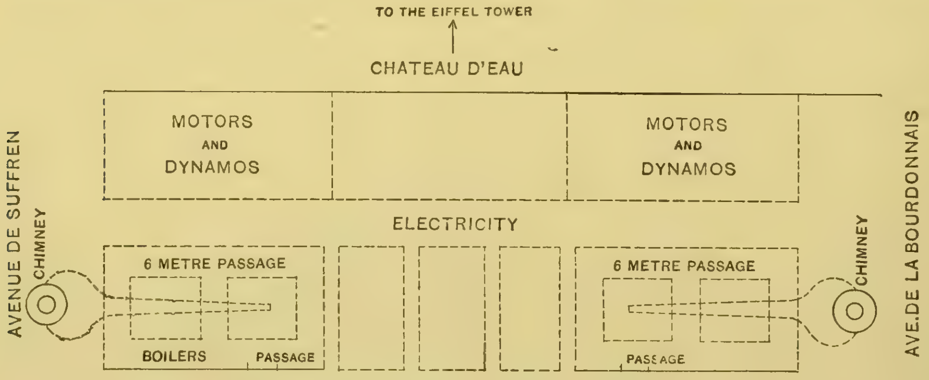
THE CHATEAU D'EAU.

In the flanking buildings there will be, on the right, on the Avenue de Suffren—Sciences and Arts, Education, Instruction, Civil Engineering, and Transportation (M. Hermant, engineer); on the left, Mines and Metallurgy (M. Varcollier, architect) and Textiles. At the bottom will be the Château d'Eau, and behind it the Electricity building, designed by M. Hénard.

The Electricity Building, with the Château d' Eau and its illuminated cascades, will form the "*clou*"—the "great attraction"—of the Exposition. The cascades will furnish the water for the boilers of the power-plant.

The artistic part of this structure is in the hands of M. Paulin, professor of architecture in the Ecole des Beaux Arts. A great arcade, about thirty metres wide and ten deep, forms the principal "motif" of the structure, which is, in all, 127 metres long. This arcade encloses a great vase, from which the water flows over into basins placed one below the other to form a series of cascades.

From an opening in the centre of the arch, at the level of its springing, an enormous waterfall, 12 metres wide, pours out, 2,000 litres per second being required to supply this singular fountain. A group of statuary, of heroic size, surmounts the arcade, which is further elaborately decorated with sculpture. To the right and left of the two pylons are still other cascades. In the evening this Palace of Neptune will be a veritable fairy-land, all the cascades being illuminated by electric lights in changing colours. Every pinnacle of the building, and every line of its architecture, will be picked out in incandescent lamps, the whole effect being continually varied from the controlling switchboards.



PLAN OF THE ELECTRICITY SECTION.

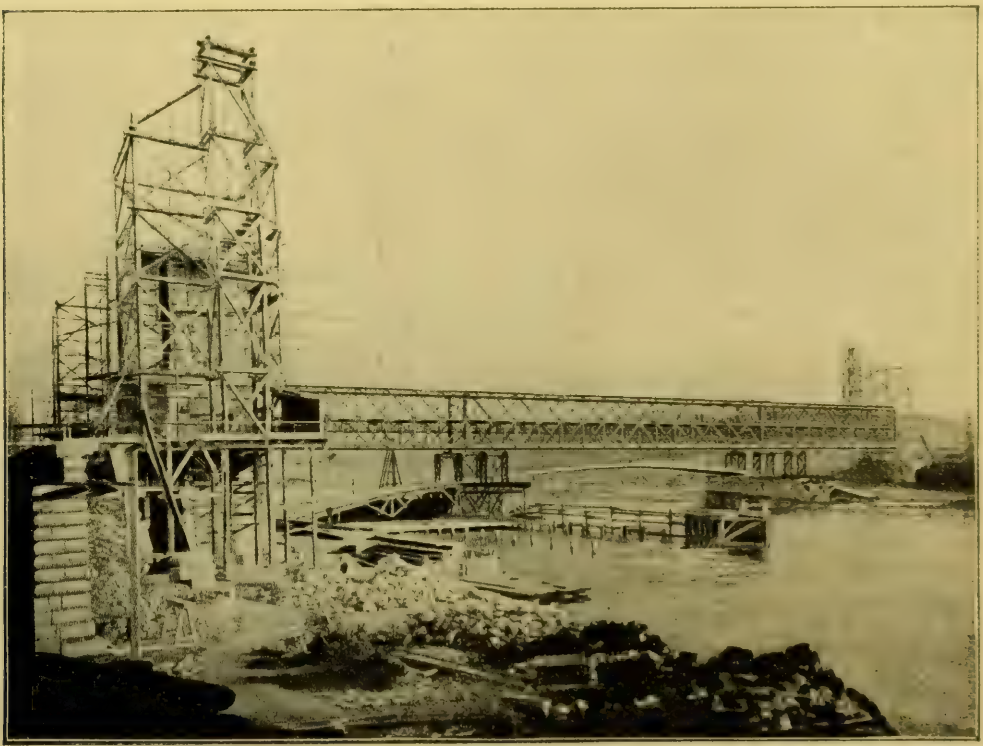
The façade of this building, as well as those of the other prominent edifices, will be garnished with panels of translucent enamels of various colors, behind which will be placed incandescent lamps, permitting an endless variety of combinations of lights, forms, and colours. When it is remembered that, in addition to all this display of light, there will be 10,000 powerful incandescent lamps on the Eiffel tower, it may readily be imagined that the evening *fêtes* on the Champ de Mars will be truly brilliant.

The great façade of the Electricity Building is built partly of metal and partly of glass, with escutcheons of hammered zinc and translucent porcelains. It is immediately behind the Château d'Eau, and will reach a height of 80 metres. The electricity division will be 420 metres long by 80 metres wide, this space including also the mechanical installation in connection with the electrical exhibit.

The arrangement of the exhibits is in three parts,—in the centre a sort of square hall, and two lateral wings. For the construction of these latter the frames of the old 30-metre gallery of the last Exposition were used, with part of the frames of the old 25-metre gallery placed at each side, so as to give the total width of 80 metres, as indicated above. A catastrophe has delayed the construction of this building. The bold project of M. Hénard, which was to move the entire 30-metre gallery from the place that it occupied formerly, was almost accomplished, when a severe wind-storm utterly wrecked the metallic structure. No one was hurt, but the frames were rendered entirely unserviceable. The Syndicat des Forges de France was immediately set to work upon new frame pieces, and it is thought that there will be no difficulty in completing the Electricity Building in time.

It seems useless to cite a list of the varied applications of electricity which will be grouped in this building. The novelties that this subject has in reserve for visitors to the Exposition will doubtless be marvellous, but the inventors are carefully keeping their secrets, and there has been, as yet, no break in their silence.

The electric current, produced upon the Champ de Mars for feeding the different motors and for the extraordinary lighting effects, will be generated in two stations. One of them, called "la Bourdonnais," and reserved for French constructors, will be installed in a building 117 by 40 metres in size, between the Central Electricity Building and the Avenue de la Bourdonnais; the other, which will be reserved for the use of foreign constructors, will be similar in size and arrangement, and will be called the Suffren station, being on the side of the grounds toward the street of that name. Each of these two groups of


FALSE-WORK FOR THE ALEXANDER III. BRIDGE.

generating apparatus will form a concession to a single representative, who will negotiate directly with the technical service of the Exposition. The administration will turn over to him the settings for boilers, the necessary foundations, and will construct, at its own expense, the smoke-collectors and chmineys; but the setting and assemblage of the steam-generating apparatus will be at the charge of the constructors.

Water for boiler-feeding and condensation will be furnished gratuitously, and the proprietor of each exhibit will be indemnified for the daily cost to which he is put for the production of steam. In each of the two installations described there will be groups of boilers able to produce, under normal conditions, at least 10,000, and probably, as a maximum, 20,000, kilogrammes of steam per hour. Independent condensers, installed by the technical service, will permit the attachment of all the engines. The water used for this purpose will come from the luminous cascade of the Château d'Eau. The same conditions attach to the electric generating groups. Both are considered as parts of the Exposition, but will be exploited and operated by the special engineering service of the Exposition itself.

The dynamos will be coupled directly, or mounted upon their shafts to the engines. This disposition allows the reduction to the smallest possible limits of the space necessary for the apparatus. Electric current will be delivered upon a switchboard—also a part of the constructors' exhibit—under the following conditions of tension, etc.:

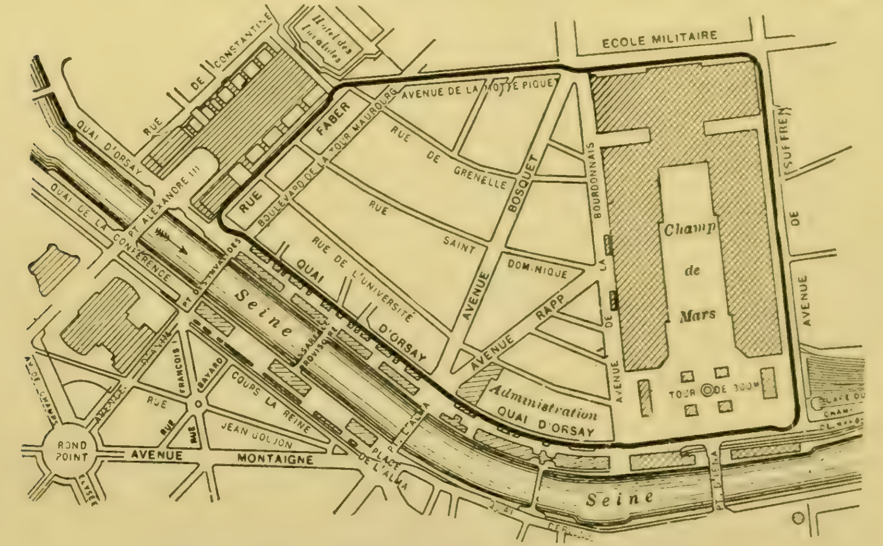
Single-phase current...... 2,200 volts, frequency, 50.
3-phase current.......... 2,200 volts, frequency, 50.
Direct-current, 125, 250, and 500 volts.

Naturally each of the generating units will be provided with its own switchboard, comprising all the auxiliary apparatus and safety-devices needed for its operation, and for connecting it in service with the others upon the main switchboard.

The boilers installed in the two main steam-generating plants will be set up in a symmetrical fashion. They will be mounted alongside of each other, and will all be of the same type in each group. Through the middle of each building will run two large flues for the reception of the smoke, these being subterranean galleries growing larger as they approach the chimney, into which they are led by curves. (See page 994) The chimneys will be monumental structures,—18 metres in diameter at the base and 4.5 metres at the summit, and having a total height of 80 metres. There will be one at each side of the grounds,—that is to say, at each end of the electrical exhibit.

The technical service of the exhibition is made up of four sections: first, Mechanical Installations, under the direction of M. Bourdon; second, Electrical Installations, directed by M. Picou: third, Handling and Hoisting Apparatus, of which M. Guyenet is the director; fourth, Hydraulic Installations, under the management of M. Meunier. This committee will have charge of various questions relating to the four divisions mentioned. The electrical committee comprises forty-four members, under the presidency of M. Mascart.

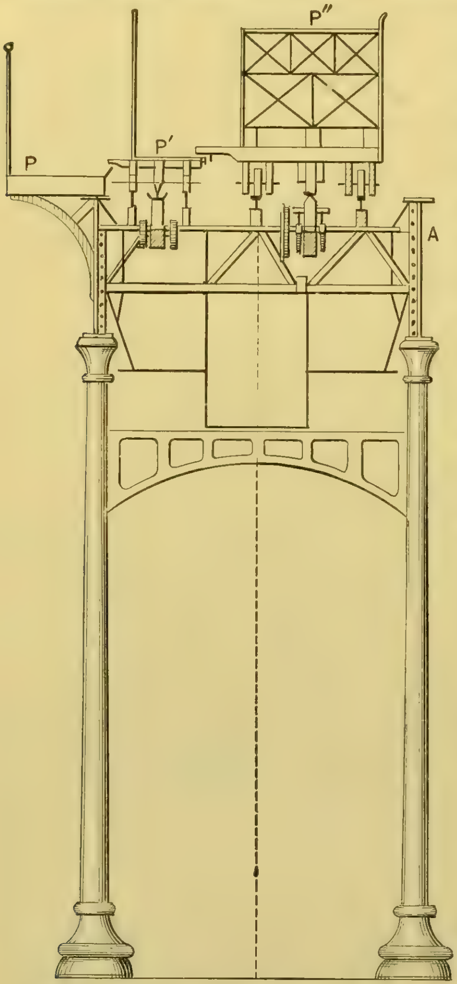
So far as electric lighting is concerned, the fact that the Exposition, like that of 1889, is to remain open in the evening, but in a more complete manner, caused it to be foreseen from the beginning that a minimum power of 20,000 h. p. would be required for the electric lighting. To this figure must be added at least 5,000 h. p., which will be required by power apparatus. The Eiffel tower will be one of the attractive elements of the illuminations at night. Its four corners and all the principal lines will be dotted with large incandescent lamps, of which more than 10,000, placed one metre apart, will be necessary for its illumination. To render the effect more startling, its illumination may be accomplished instantaneously by the working of a series of switches, operated by a single key situated at a distance; the object of this being that distinguished personages may, by a simple touch, illuminate the tower, whose luminous silhouette will be visible within a radius of 40 kilometres around Paris. The lighting of the big wheel, similar to that shown at the Chicago Exposition, in 1893, must not be forgotten. This is in place, and is already ornamented with about 1,000 incandescent lamps. The electric lighting is not confined at all to the Champ de Mars; it will extend to both banks of the Seine, which will be festooned with electric



PLAN OF THE ROUTE OF THE MOVING WALK-WAY.

globes, and to the bridges of the Esplanade des Invalides, while illuminated boats, taking part in a sort of Venetian fête, will ply about the river.

For the solution of the difficult question of interior transportation at the Exposition,—a question presented in a circular issued by the ministry of commerce and industry in August, 1897,—the examining committee had to choose between five principal projects, all of them electrical. The French Thomson-Houston Company wished to establish a single track of one-metre gauge, and to install at Ivry a station of some 4,000 h. p., generating polyphase current. Sub-stations and transformers were to be established in the grounds of the Exposition for moving the trains, which were to consist of two motor-cars, each of about 160 h. p., hauling two, three, or four trailers. The Decauville Company also desired to build a one-metre-gauge railway, to be operated by electricity. The electric company which serves the region on the left bank of the Seine had an almost similar project, the electrical energy to be generated in its own station. The fourth project, that of M. Francq, proposed a double track of standard gauge and accumulator vehicles. The fifth and last proposition, that of M. de Mocomble, was adopted. The plan comprises two parts; an electric railway with one-metre gauge, and a moving walk-way of two speeds.



SECTION OF MOVING WALK-WAY.

This last part of the project was accepted on account of the excellent results shown by such moving walk-ways at Chicago, in 1893, and Berlin, in 1896; but in this case they are not to operate through a distance of a few hundred metres, as at the former Expositions, but are to run through the Champ de Mars to the Esplanade des Invalides and back by the Quais to the point of starting, thus making a circular path nearly five kilometres in length. The exact route is the following, shown also in the plan (page 997): Beginning at the Quai d'Orsay, through the Avenue de la Bourdonnais, Avenue de la Motte Picquet (outside the limits of the Exposition), Esplanade des Invalides, and Rue Favart. The walks will be carried upon a metallic trestle-work, consisting of two parallel girders resting upon cast-iron pillars 6 metres high. Passengers go up to the walk-ways at the principal stations by a moving inclined plane; at the intermediate stations there are staircases. Arrived at the level of the walk-ways, the passenger finds himself upon a fixed platform, P (page 998), or sort of walk, 0.9 metre wide, upon which he can stand while waiting for a convenient opportunity to get on the second platform. A light iron railing guards the exterior of this stationary part of the walk. The second platform, P′, 0.8 metres wide, moves at the speed of 4 kilometres per hour, its edge running close to that of the stationary walk. Finally, a third platform, P″, 1.30 metres wide, runs at the speed of 8 kilometres per hour. Upon this are mounted benches, each seating three persons and all facing in the direction of the movement of the apparatus. The two platforms will have movements entirely independent of one another. They are furnished with an axial girder, A, placed under the floor and resting upon rollers situated between the two rails of the track at every 6 metres. These wheels are not all equipped with motors, the motor wheels being 39 metres apart. To each of these is connected a motor of 6 h. p., which in this way transmits motion to the axial girder and to the platforms themselves. A special generating-station will probably be built, to furnish about 400 h. p. for these motors. The carrying capacity, or number of seats per hour, is estimated at 38,880, the maximum speed of motion of any part of the apparatus being 9.72 kilometres per hour. M. de Mocomble has offered to pay one centime per passenger carried, the fare being ten sous, whatever the distance traversed.

The small electric railway will run around the grounds in a direction opposite to that of the moving platform, and will have a single track of one-metre gauge. The trains will comprise three trailers and one motor-car, carrying four motors of 35 h. p. each. These trains will accommodate 9,500 passengers per hour, the fare charge being five sous. The system of traction will be left to the choice of the *concessionaire*, —between the overhead trolley and third rail. The commission, before definitely undertaking the work of construction, have invited M. de Mocomble to give a trial of his moving platforms upon an enclosed circuit of 350 metres. These experiments will probably take place in two or three months.

The cost of installing the platform is estimated at 7,000,000 francs. It will thus be necessary, during the two hundred days of the Exposition, in order to repay this cost, to take in 35,000 francs per day, or fares from 70,000 passengers. The walks will be in operation for 14 hours each day.

The greatest inconvenience about this project is that it serves only the left bank of the river; the Champs Elysées and the buildings on the right bank of the river will be practically isolated. This difficulty was found to be insurmountable, and there is some question whether or not there are bridges enough to connect the two parts of the Exposition on the opposite sides of the river. It was to remedy, in part, this defect that the commission accepted a recent project of an aerial car (a sort of telpherage scheme) suspended by rollers on a taut cable and hauled by another cable wound up at one side or the other, on windlasses, by electric motors. This extraordinary arrangement is to be erected about 50 metres below the new Alexander III bridge. The conductor of the car will operate it through signals transmitted to the motors on the banks. An electric lantern will illuminate the front of this curious vehicle. The view which will be obtained during this flight of 118 metres, at 9 metres above the water-level, of all the illuminations of the bridges and the shores of the stream, will certainly be unique and admirable.

This *résumé* serves to give an idea of the condition of work upon the Exposition and its plans and projects,—all that one can now foresee certainly. No other word than "immense" can describe the *rôle* to be played by electricity. More than 20,000 h.p. will be used for the lighting alone of the grounds and buildings; in addition, 10,000 h.p. will be used for motive power; and there is actually under construction, at Molineaux, outside the fortifications, a supplementary power station of considerable size, of which the total horse power has not yet been made public.

EDITORIAL COMMENT

A general view of the technical literature of Europe and America month by month reveals certain waves, or groupings, showing the tendency which various subjects have to attract attention simultaneously in different parts of the world. Thus The Engineering Index this month contains titles of numerous papers upon subjects relating to public health, sewage-disposal, pure-water supply, and general sanitation, there being an undoubted revival and growth of public interest in the application of engineering methods to the prevention of disease and to the preservation of public health.

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Again, there appears to be a similar awakening in everything relating to workshop administration, including organization, cost-keeping, provision for depreciation of plant, and introduction of improved machinery, these subjects being discussed in leading articles appearing in prominent journals on both sides of the Atlantic. It is beginning to be appreciated generally that success in engineering work, commercially considered, depends very greatly upon the manner in which the problems of shop administration are treated, hence the interest taken in such matters in the technical press.

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In the domain of electricity there is little novel to be noted; but, at the same time, the extension of the application of electricity to power transmission goes steadily forward, there being the customary proportion of articles descriptive of hydraulic and electric power plants. Papers concerning the great stations at Paderno and Lyons, and the proposed control of the Swiss Rhine, have appeared; while numerous examples of electric power application, notably in mining work, are described.

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Railway affairs contribute several subjects of interest and importance to the list of articles in the Index, and from each side of the ocean comes information concerning great terminal works. In Boston the huge Union Terminal is fully described in several journals, while the progress of the work on the prolongation of the Orléans railway, in Paris, and on the construction of the new terminal of the Quai d'Orsay, is recorded. The subject of train speeds continues to be discussed, and the remarkable performance of the new compound engines of the Northern Railway of France, in regular service, is a subject of admiration and comment. A closely-related topic is that of train resistance, and the results of important tests, as well as the discussion of methods of computation of the resistance of trains of various weights at different speeds, form the subject of several papers.

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Interest in both the Nicaragua and the Panama schemes for the isthmian canal continues, especially in view of the prominence of the question before the United States Congress, the publicity given to the report of the Nicaragua Canal Commission, and the passage of the bill by the United States Senate, all of which furnish occasion for comment and criticism in the technical press. The report of the Senate committee upon the regulation and control of the Mississippi river has also attracted much attention in civil-engineering circles in the United States, the document being an important presentation of a problem of great consequence to a number of States.

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A kindred subject to that of the control of rivers is the distribution of water for irrigating purposes, and, especially in the western United States, progress has been made in introducing more rational and scientific methods of measuring the flow of water for irrigation than those formerly in vogue.

Other matters of interest to the civil engineer are the growing subject of reinforced concrete construction, lately discussed theoretically in papers presented before the French Academy; practical applications of the method to bridge-construction are noted both in Europe and America. Fireproof building construction is also attracting renewed attention, this question doubtless being influenced by the behavior of recent structures in actual test.

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Various papers upon the progress of the construction works of the Paris Exposition continue to appear, there being a noteworthy presentation of the engineering features of the works at a meeting of the American Society of Civil Engineers, the proposed transportation features being especially considered. The general activity which is reported upon the exposition works appears to confirm the assertions that no delay will be permitted to interfere with the completion of the various structures by the appointed date.

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The launch of the White Star steamship Oceanic has attracted attention mainly because of the fact that the dimensions of the Great Eastern have at last been exceeded; but, from the point of view of the shipbuilder, this latest addition to the transatlantic fleet is of interest because of the improved methods which have been employed in her construction, and the probability that the success which has attended the use of power tools to so great an extent will cause their employment in other yards than those at Belfast.

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In the field of steam engineering the subject of multiple expansion continues to evoke discussion, and, while papers in the continental press contain methods for determining the best cylinder ratios for triple- and quadruple-expansion engines, the tendency in America is rather to look with favor upon the use of compounding in two cylinders only, with a much larger ratio than that formerly employed. The influence of constructive details upon economical performance and upon the possibility of the attainment of higher rotative speeds also receives attention. The subject of smoke prevention is still discussed, but mainly with regard to the suppression of a nuisance, and not as a feature of economy in combustion.

Automobilism remains prominent in certain of the technical journals, especially in France, and there is every evidence that mechanically-propelled vehicles are passing from the limited sphere of the pleasure carriage to the wider field of general commercial service.

Artificial refrigeration forms a fertile subject for papers relating to the practical application of thermodynamics, and reports of tests and accounts of special installations furnish material for several valuable articles. Many papers on machine tools and special methods of work appear in the department of mechanical engineering, a field which has maintained its usual activity during the month.

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The technical literature of mining and metallurgy is particularly full, and both in the department of mine operation and of the subsequent treatment of products a great variety of papers is found. The matter of specifications for structural steel forms a subject of animated discussion among manufacturers and inspectors of steel in the United States, and the relations between the chemical composition and the physical characteristies of steel are made the basis for proposed modifications in existing methods of specification.

The application of electric power to mining plants is making rapid progress, and, in Germany especially, some notable installations of electric underground pumping machinery are recorded. Methods of preventing mine explosions, and improvements in life-saving apparatus continue to receive notice, and, on the continent at least, it is not too much to say that improvements in this important line of work are progressing most actively.

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As is usual at the beginning of the year, there are many reviews of the progress in various departments of engineering during the past year, and while there are no very notable achievements or discoveries to be recorded yet on every hand there is abundant evidence that sound and material progress has been made; a progress which may be more apparent when thus viewed as whole, than when noted, as here, from month to month.

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General H. L. Abbot, whose computations Mr. Hunter quoted in his article on the Panama canal in our February issue, advises us that the water impounded by the Alhajuela dam is sufficient to feed the canal " during the three months of the 'dry season' when the normal flow of the river is insufficient. This flow has been carefully determined by actual measurement, and the minimum volume noted in any month has been used in the estimate." He informs us further that the estimate of $100,000,000 for completing the canal is *not* inclusive of the cost of administration or of payment of interest out of capital during the period of construction.

* * *

Mr. Orcutt expresses, in this issue, his belief that " the majority of the best mechanical engineers in America have no college education." This may be the fact —though the old order is fast giving place to the new—without affording the slightest ground for his inference that " college training . . . as at present carried out, seems " to " unfit a man for practical machine-shop work."

The technical school is of comparatively recent growth. To many engineers who are now most prominent and most justly honored it was not accessible. They succeeded without it; by no means does it follow that success would not have been more rapid if the road had been easier.

It is part of their triumph to have replaced empiricism by the higher knowledge of properties and laws which enables the projection of new work far beyond the range of experience. The "college training, as at present carried out," is generally designed only to place this portion of the work of the great pioneers within the reach of the following ranks of the profession. It proposes to give a clear and accurate knowledge of the "why," and thus aid in a speedier and more thorough acquisition of the " how."

Rarely, the technical school weakens its case by pretending to give its students the instinctive readiness which comes only from long practice; but the institution should not be condemned by its infrequent abuse. Many things in the training of a physician or a surgeon must be gained by long practice and observation in the clinic and the hospital; one would hardly, on this account, condemn medical education or consider the after training "a corrective dose."

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Gen. Otis has repeated, at Manila, the object lesson which Gen. Lord Kitchener made so terrible as well as so brilliant at Omdurman—the lesson of the immeasurable supremacy conferred by mechanical skill.

Of course, discipline must be granted a most important factorship in either result; but there is some ratio at which fanaticism, or mere blind dash, will overcome any discipline; there is practically no comparison possible between the fighting tools and the fighting engineering of the savage and those of the Anglo-Saxon.

It is a bitter way the white man has of beginning his teaching of the " silent sullen peoples," this

" Landin' 'isself with a Gatlin' gun,"

but it proves the power of civilization in a way there is no possibility of their misunderstanding. It is the "concept they have," from which he can proceed to "the concepts they have not" yet,—the concepts of sanitation, of water and food supply, of proper buildings, good roads, intercommunication, and industry. The engineer as a war-maker justifies his sternness by opening the door to the engineer as a health-maker and a wealth-maker.

* * *

When acetylene leaped into sudden prominence as an illuminant it was feared that electric-lighting stations might suffer from its competition. Now it is becoming evident that the effect of its general introduction will be really beneficial to the electricity-supply industry.

The brilliancy of artificial lighting has increased astonishingly. Until gas gave them a new standard of illumination, our ancestors were satisfied with dim and flickering candle-light,—but once accustomed to the more powerful light they could not return to the visible darkness of the rush-light epoch.

When electric light appeared it was seen that gas was inferior in steadiness, power and color. But, notwithstanding, the consumption of gas was increased by the growing extension of electricity supply, simply because the greater brilliance of the new illuminant set a new standard for lighting. For identical reasons the effect of the incandescent gas burner upon the electric-lighting industry has been beneficial. It seems, therefore, that the more general use of acetylene will similarly act as a stimulant to other branches of the illumination-supply industry.

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It is not generally known that the theoretical limit of attainable candle-power from acetylene, made from calcium carbide produced in an electric furnace, is somewhat less than that actually obtainable from incandescent lamps actuated by the same amount of electrical energy. As a matter of fact, a given quantity of light produced by burning acetylene necessitates to-day an expenditure of from two to three times as much energy in making the carbide as would be required to generate the same light with incandescent lamps. This difficulty is only apparent, however, because inexpensive water-power can be used for making the carbide, which may be transported to any distance. In a sense, calcium carbide represents the stored light-producing ability of the energy used in its manufacture.

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In the same connection another singular fact is apparent. There is absolutely no standard or unit of illumination. An architect or an engineer confronted with the problem of lighting an interior, for example, with whatever sort of illuminating agent, has no more reliable criterion to guide him than common experience. His method of solution will inevitably resolve itself into guess-work. He does not know what intensity of light he wishes to attain, and if he did he would not know how to set about procuring it. Heating and ventilation have been reduced to fairly exact sciences in which, at least, there are degrees of intensity and units of measurement; but there is nothing tangible about lighting. The prevailing rule seems to be that a little more than enough light is just about right.

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In the January number of THE ENGINEERING MAGAZINE a short editorial paragraph called attention to the fact that the supply of gutta-percha is limited, and that the Pacific cable, so much talked about nowadays, would probably consume most of the gum in sight. Just why the daily press should have united in a complete misunderstanding of the item is a little hard to understand, but from one end of the United States to the other newspapers have copied it, and, with about three exceptions, have used as a heading either "Rubber is Scarce," or "Hurry Pacific Cable or Rubber May Be Scarce." As the item in question did not mention rubber anywhere, and as rubber is far from scarce, it is interesting to see the extraordinary unanimity with which the copying journals assumed that the paragraph meant rubber when it said gutta-percha. Perhaps the first man made the mistake and all the rest copied him; or—dreadful thought!—perhaps the item was spread about by someone who thought he would be able to bull the rubber market with it. This seems a good opportunity to say that, while gutta-percha is not plentiful, there is not the least scarcity of rubber, as many new areas are producing it and both quality and quantity of the product seem to be satisfactory and sufficient.

THE BRITISH PRESS

Review of Leading Articles

The Present Status of Sewage-Purification.

AMONG the papers at the Birmingham congress of the Sanitary Institute were several of importance upon various phases of the important question of sewage-purification and -disposal, the whole, together with the discussion, forming an excellent record of the present status of the subject.

The papers were by such well-known experts as Messrs. Kenwood, Butler, Rideal, Scot-Moncrieff, and Adeney, the discussion including remarks by Professor Frankland, Mr. Dibdin, Dr. Sims Woodhead, and the authors, so that the papers and the discussion represent a consensus of opinions of specialists.

It now seems to be generally admitted that bacterial action is the one method of sewage-purification, and that the only question is that of assisting nature in this work, and thus accelerating, and to a certain extent controlling, this action. As Professor Frankland remarked, every particle of the sewage of our forefathers had been disposed of by bacteriological processes, and, so far from being entirely novel, such processes are as old as life on the globe. This fact was also emphasised by Mr. Dibdin, who showed that, the more the question was studied, the more clear it became that the main reliance had always been upon the action of the micro-organisms.

The most important lesson learned in the course of recent experience is that the continuous life action going on in the foul water from the time it is first produced until it is discharged in a purified condition must not be interrupted. Any treatment by excessive doses of lime, carbolic acid, or any material which acts as a disinfectant, will arrest the natural purifying action for a time, although this will reassert itself and continue its action at a later point.

It seems to be a well-established fact that disease germs are not conveyed by the sewage effluent. Pathogenic bacteria do not thrive at a temperature much below blood heat, and are rapidly crowded out and destroyed by the immense numbers of ordinary bacteria present in sewage. Experiments by Dr. Sims Woodhead and Dr. Pickard seem to demonstrate that the typhoid bacillus does not survive in the septic tank, and that in the filter beds there is a further biological elimination, "so that there is no chance whatever of the filtered effluent causing typhoid fever, if passed into the river."

There seems to be no doubt that both the anaerobic and aerobic processes are of value in connection with sewage-disposal, the former for the solution of solid matter and the latter for the purification of the liquid sewage.

When the sewage is submitted to the liquefying action of the anaerobic bacteria, in an air-free dark space, the solids are dissolved to simpler organic compounds, with the final production of carbonic acid, ammonia, and volatile gases. The experimental tank at Exeter has never been cleaned out, and it is an undoubted fact that solid materials, such as paper, string, rags, feathers, etc., do disappear, and the sewage is converted into the liquid form.

When the liquid form is attained, the aerobic bacteria may be depended upon to produce the final purifying result, and Mr. Adeney has outlined very clearly this portion of the subject.

The following facts are known;

"1. That the agents which bring about the purifying changes are bacteria;

"2. That the germs of these organisms exist practically everywhere in nature;

"3. That the ordinary bacteria of nature can attack, and completely oxidise, probably most, if not all, known organic substances, with the exception of antiseptics;

"4. That the chief condition necessary for the continued healthy life processes of these organisms is an adequate supply of oxygen in the free state or in certain forms of combination.

"This holds good for the solid matters in suspension, as well as for those in solution.

"5 That the chemical changes set up by these organisms, under the condition of a sufficient oxygen-supply, result in the complete breakdown of the organic matters in a foul water, and in their conversion to carbonic acid, ammonia, water, and nitric acid, together with the formation of small quantities of colouring matters, which, although organic in composition, are not to be regarded as polluting matters, since they are to be found present in more or less quantities in all waters, including first-class potable waters.

"The process, then, of purification of foul waters by natural agencies is a true bacterial fermentation,—a process presenting *per se* no danger to public health, if an adequate supply of oxygen be maintained during its continuation, but capable, in the absence of such an adequate supply, of engendering conditions, in the highest degree dangerous to health."

It will be noticed that Mr. Adeney asserts that the anaerobic bacteria are capable of decomposing both solid and liquid matter, but this is a point about which experts as yet disagree.

Notwithstanding some minor differences of opinion, there is no doubt that rapid progress is being made in the successful handling of both processes, and, in the words of Mr. Scott-Moncrieff, the bacterial purification of sewage is certain to be generally adopted at an early day as a thoroughly satisfactory solution of the question.

The Organisation of Manufacturing Works.

It is everywhere becoming apparent that manufacturing supremacy depends to a very great extent upon systematic organisation, and that the only way in which the growing competition with British industries can be successfully met is by a systematic reorganisation, not only of machine tools and methods of work, but also of the conduct of manufacture.

An interesting paper read before the North East Coast Institution by Mr. Tom Westgarth treats mainly of the organisation of shipyards and engine-works, but many of the points apply to manufacturing establishments in general.

In the first place, it is a mistake for an establishment to attempt to make too great a variety of products, and it is not wise to attempt to make in a general works machinery and parts of engines which are specialties of other makers; for instance, it is probably cheaper to buy pumps and auxiliary engines than to make them. In many cases it is not well for engine builders to make either their own castings or their own forgings, unless they have enough work to keep a foundry and a forge busy all the time.

The arrangement of tools is an important matter, and one to which more attention is given in the United States than in Great Britain.

"In placing tools, care must be taken that the rotation of work should be continuous. The plan, frequently adopted, of grouping similar tools together, as, for instance, having all planing machines in one part of the shop and all drilling machines in another, is not always satisfactory, and sometimes involves unnecessary labour in carrying work to the machines.

"The tools should not be placed in groups of one kind, but with a view to the particular work which is to be done in conjunction with other machines."

The importance of a well-organised tool store, in which should be kept tools, gauges, templates, working drawings, etc., is emphasised, and the necessity of having the care of these tools in the hands of a skilled mechanic, who can superintend the repairs and construction of new tools, is shown.

Mr. Westgarth makes some excellent suggestions regarding the administration of workshops.

"With regard to the staff, it is quite as important that the staff should be both sufficiently good and sufficiently large for the work to be done as to have a well-laid-out works with good machinery. It is, of course, easy to err upon the side of having too large a staff, but a very common error is to have the staff too small.

It is impossible to calculate the loss in a shipyard or engine works which will take place if the drawing-office is undermanned and the works behindhand.

"Most capitalists quite agree as to the necessity of having the best tools, and plenty of them, but the writer is afraid the majority consider that a large staff is a waste of money. Not only is it important that the drawing-office should be well manned, but also the office, and particularly the cost-keeping department.

"It is of vital importance that the costs should be kept up to date, and an abstract of costs furnished, if possible, weekly, and made up to the end of the previous week, to the responsible managers, so that they may know how costs are progressing."

So far as the question of costs is concerned, it is quite possible, even in the most extensive establishments, to install cost-keeping systems which enable the cost of any piece of work to be ascertained upon inspection at any stage of the work.

The question of finishing work in stock is also touched upon by Mr. Westgarth, and the economy of completing machines in lots, rather than in single orders, is shown to over-balance in most cases the loss of interest on the capital locked up.

In a great number of cases the systematisation of designs for the express purpose of enabling many parts to be made in quantity is the true secret of economical production, and, although the parts may belong to machines of different classes, the grouping of sizes and the judicious arrangement of details to permit duplication of parts are among the secrets of the reduction of shop costs.

Payment by results is strongly recommended, from the managers and the foremen down to the workmen, the managers being paid partly by a percentage on the profits of the work of their departments, and foremen partly by a bonus upon the quantity of work turned out, while the piece-work system is advised for the workmen.

"It should be clearly grasped by capitalists that the days of very large profits from engine building are past. The competition for work is now so great, and the standard of requirements so high, that it is only in good years that a large profit can be made; and experience has taught us that trade fluctuates so much that good years are invariably followed by bad ones, and therefore, when a large profit is made, it should certainly not all be divided, but part should be kept for a reserve fund to equalise dividends in bad years.

"If an engine works can pay steadily 5 per cent. on the capital, and gradually accumulate a reserve fund, after making proper provision for depreciation, and taking care to buy new machinery and tools, and also make minor extensions from revenue, capitalists should be satisfied that the investment is a good one, and, if such a policy could be carried out, there would be much less difficulty in getting capital subscribed for manufacturing purposes.

"Manufacturers are not entirely free from blame for the present peculiar way in which the investing public will much more readily put money into mines and all kinds of speculative investments abroad rather than into shipbuilding and engineering companies at home."

The Increased Efficiency of Coal.

THE importance of obtaining the highest possible efficiency out of the fuel used in the various operations in the arts is the subject of an excellent article in *The Colliery Guardian*, and the comparisons there given of the advances made during the past thirty years in the economical use of coal show a material progress.

In the case of marine engines some very interesting figures are given from British warships, the average fuel-consumption between 1861 and 1872 being 4 to 5 pounds per h.-p. hour, a figure which was reduced to 2.75 pounds in 1878, and to 2.5 and even 2 pounds in 1888, while at present a horse power is obtained with 1.5 pounds of coal per hour in a number of instances.

This continually-improving economy has been attained by the combination of several improvements, the principal being pressure, multiple expansion, and improved construction, by which useless resistances and wastes were reduced. The large losses of steam due to cylinder condensation have as yet resisted any reduction by any other means than that obtained by multiple expansion and jacketing, although superheating has given most encouraging prospects as to further improvement in steam economy.

It is not only in marine engineering that increased fuel efficiency has been secured; both railway and stationary practice show good results.

On the London & North Western Railway the latest figures show a fuel-consumption of 35.7 to 38.8 pounds of coal per engine-mile, as compared with 48.5 pounds a few years earlier.

American stationary engines have been constantly improving in steam economy; while in 1870 the most economical mill engine used about 20.5 pounds of steam per h.-p. hour, this had fallen to 16.5 pounds in 1873, while at present there is a record of 12 to 13 pounds.

A similar economy has been obtained in connection with the manufacture of coke. Not only are the bye-products recovered, but a greater percentage of coke is produced from an inferior quality of coal, and the resulting fuel is of greater efficiency. With the old beehive oven, only about 65 per cent. of coke was produced from a given quantity of coal, and the bye-products were lost, while, with the modern forms of recovery ovens, there are no waste products, and 75 per cent. of coke is obtained.

"In regard to the blast furnace, the increased efficiency of the coal and coke used is very clearly shown in the fact that, while in 1870 the consumption of fuel per ton of pig was 23 hundredweight, it is now less than 20 hundredweight, in some cases falling as low as 17 hundredweight."

These results are largely due to mechanical improvements in the furnaces and a better knowledge of the chemical processes involved. More work is being got out of a pound of coal than it was thought possible to get ten or fifteen years ago, and at the same time less waste is incurred.

"Another direction in which increased efficiency of coal has been exhibited is in the advances which have been made in the production of water gas. In the old water-gas generator, of small size, only from 30 to 38 per cent. of the value was utilised, out of 85 per cent. carbon in the coke. Now, under the newest system, the calorific value of water gas from one ton of coke is over 82 per cent.

"These instances might be multiplied, no doubt, but they at least serve to indicate the movement which is going on in industrial affairs, which is tending to eliminate waste and to extract every unit of work and value from the substances and materials which are, in the majority of cases, becoming scarcer every day."

The Market for Traction Apparatus.

THE effect of injudicious legislation in hampering trade is nowhere better shown than in the present condition of the British market for electric-traction apparatus. The tramways act, combined with the conservatism of local authorities, has so narrowed this field of enterprise that there has been no incentive for the British manufacturer to prepare to execute orders for electric street-railway machinery, the consequence being that such orders are, for the most part, placed in the United States.

Commenting upon this state of things, the *Railway World* says: "We are not inclined to complain of this: on the contrary, it is fortunate for companies and corporations that the resources of the great American electrical manufacturing establishments are at their disposal on such favourable terms; for the simple fact is that British makers have not yet put themselves in a position to meet the demands, particularly as respects the important element of time in delivery." The large, and by no means cautious, market that American manufacturers have enjoyed, and the lack of conservatism among manufacturers and managers, have aided in no small measure the tremendous exploitation of electric tramways in the United States. "Experiment is the delight and extravagance of the manager of every undertaking, and far be it from us to say that in the end it is not justified. It has, at least, produced sixteen thousand miles of electric railways in the States, and it has invaded this country to such an extent that there is scarcely an electric tramway that is not eloquent of its success."

The major difficulty with the British manufacturer of traction apparatus seems to be that he has not prepared himself to meet competition from abroad. This unpreparedness is evident, not only in the electrical manufacturing trades, but as well in most others where the American machine tool is bringing its product into competition with the more costly output of the British machine works. The specialisation of electric-tramway apparatus has been carried to the highest point in America ; designs and patterns have been standardised, after costly, and often disastrous, experience has shown the forms fittest to survive; manufacture in its strictest sense—the duplication of a standard machine with the least expense—is carried on universally, departures from the accepted design being almost unheard of. With this specialisation of works and patterns, assisted by the use of the most economical methods and tools, the British manufacturer is in no position to compete. He must be content, first, to learn new methods of organising his work and the use of new tools,—experience acquired only after repeated failures ; but he must also be freed from the limitations of the tramways act and the dictation of the trade-union.

All over the continent there is awakening a lively interest in electric traction. Much of the apparatus employed is of American origin, but British firms have been fairly represented, and have shown that they are able to produce excellent apparatus. It seems that only the British isles are still asleep under the soporific effect of ultra-conservative, though well-meant, legislation.

The Industrial Prosperity of Great Britain.

MANY attempts have been made to deduce the industrial condition of a country by a comparison of its exports and imports, and, when the latter exceed the former, some excellent people wonder how long the resources of the country can stand the drain.

A very excellent editorial in *Engineering* upon the subject of British exports and imports, based upon a recent paper before the Society of Arts by Sir Robert Giffen, shows that there are many conditions besides exports and imports which enter into the prosperity of a nation, and that among these the returns derived from the work of the engineer form no insignificant part.

Ever since 1854 there has been an excess of imports over exports, and, if this alone were any indication of the condition of the country, bankruptcy should have been reached long ago; hence there must be some fallacy in the argument.

The apparent anomaly of prosperity for a nation which persists in spending more than it earns is partially explained, according to Sir Robert Giffen, by the fact that the values are not expressed by the same standard, a ton of coal being a ton of coal whether in a mine or in a ship's bunker, but valued at four or five times as much in the latter case as in the former. The official returns assess imports at their value on arrival, while the value of exports is calculated on their departure. To the discrepancy occasioned by this inconsistent mode of valuation about sixty of the eight hundred and seventy-five millions of Great Britain's adverse balance of last year may be charged, this being what Sir Robert Giffen calls the "invisible export."

Another source of revenue to England lies in the large amount earned by the commission business, due to the fact that she is the centre of the monetary transactions of the world ; besides which the business of ocean transport is largely in British hands, and the profit from the transport both of merchandise and passengers should be included.

Then there is the so-called "private income" coming to England in the form of returns on English capital invested in other countries. "There are English partners in foreign businesses who send their money home, while the share owned by British residents in State loans, foreign railways, water-works, and other public undertakings is enormous."

Taking these returns, together with the

sums remitted from India for salaries, pensions, and annuities, we have something more than seventy millions a year to be added to the revenue of Great Britain from the "private fortune" of England as compared with trade and professional earnings, this representing a principal of not less than 1,500,000,000.

Viewed in this light, it will be seen that the excess of imports is to a great extent paid for with the returns from invested profits, and represents in large portion the tribute paid to enterprise, thriftiness, and natural advantages. England makes all the railways, harbours, roads, and bridges she needs, and then lends her balance, receiving in return an excess of imports.

It is in this form of wealth that the work of the engineer appears; hence a little thought will show that the product of genius and brains is an invisible export the value of which can hardly be counted in a monetary sense.

"In other words, our industrial prosperity is in our own hands, and, so long as England remains true to itself, its commercial influence is not likely to wane, although it cannot in the nature of things retain the overwhelming preponderance over that of other nations it once possessed. Enough trade will, however, remain to afford the comforts of an advanced civilisation, and we should be churlish indeed if we grudged other people a share of the increasing happiness that has come to our race in these later days of progress; a progress in which the engineer has played the most conspicuous part."

The Deterioration of Steel Rails

THE advances which have been made of late in the study of the physical properties of metals, especially in connection with the use of micro-photography, lend especial interest to two papers recently presented before the Institution of Civil Engineers,—one by Mr. William G. Kirkaldy, upon the "Effects of Wear upon Steel Rails," and the other by Sir William Roberts-Austen on the "Microphotography of Steel Rails."

In the course of an examination of some rails which had broken in service Mr. Kirkaldy became convinced that the nature of the steel had been affected by the action of the loads.

It was found that the breakage of the rails resulted from failure commencing at the top surface, and not from the bottom, as appears to be the usual belief, the deterioration being confined entirely to the top, or running head. The deterioration seemed to be of the nature of a mechanical hardening of the surface under the action of a rolling load.

In some instances the hardening develops into a species of disintegration, minute transverse cracks being formed, which ultimately result in failure.

Since the bottom portion of a rail is not subjected to the hardening action of the rolling load, the metal in this portion may be taken as a fair representation of the original material, and the difference in the results of tests made upon the two portions serves to show the extent and character of the deterioration.

The deterioration having been determined for various specimens, there arises the important question: What is the best means of diminishing the action which produces these injurious effects? The causes of deterioration may be separated into those due to situation and those which depend upon the chemical and physical constitution of the rail itself.

The conditions due to situation include the effects of the stoppages of trains, which again vary, depending upon the place where the stop is made,—on a favourable, level piece of track, or on grades or other locations in which the brake action is more or less severe.

Injurious effects are produced also on rails situated at the starting positions of trains, where the skidding, or climbing action, of the driving-wheels comes into play. It is therefore important, in investigating any specimen of rail, that the nature of the location from which it has been taken should be known. The investigations of the micro-structure of rails, as indicated by Sir William Roberts-Austen, involve the use of etching and staining methods.

The most generally useful information

as to the structure of the steel is obtained by treating a highly-polished surface of a section with an infusion of liquorice in water, which stains the pearlite a dark tint and leaves the ferrite unacted upon.

When such a section is magnified between 100 and 150 diameters, the relation of the pearlite to the ferrite can be clearly seen.

Normal rails generally consist of patches of pearlite set in ferrite, but, although this structure is common to all rails, the ratio of the areas differs widely, the carbon increasing with the area of the pearlite.

The best condition for rail-steel is that in which the ferrite and pearlite appear in a closely-interlocking relation, while, if the ferrite appears in large enclosed polyhedrons, it indicates that the temperature before rolling was too high.

By conducting a careful series of experiments of this nature upon rails of which an accurate history, so far as location and service are concerned, has previously been obtained, much doubtless may be learned as to the causes and prevention of rail breakages; and the importance of obtaining a careful record of the duty performed by worn rails should in every case be recognised in securing specimens for investigation.

The Oceanic.

WITH the launch of the new White Star steamer Oceanic, of which an excellent description is given in recent issues of *Engineering*, the dimensions of the Great Eastern are at last exceeded, and the advances which have taken place in naval architecture and marine engineering in the thirty years which have elapsed since the construction of Scott Russell's great ship are such as to make some comparisons of interest.

So far as actual dimensions are concerned, the difference in size is not very marked; the Great Eastern was 680 feet l.w.l., 83 feet beam, and 57 feet 6 inches deep, with a displacement of 27,000 tons; while the Oceanic is 685 feet l.w.l., 68 feet beam, and 49 feet deep, the displacement being 28,500 tons.

It is in the powering of the two vessels that the great advance in marine engineering is most apparent, and one can readily see how far beneath the actual requirements the power of the engines of the Great Eastern was.

The Great Eastern was fitted both with screw and paddle wheels, the combined power of both sets of engines being given as 2600 nominal h. p., and the actual capacity being about 12,000 h. p., while the engines of the Oceanic are estimated at about 28,000 h. p.

In the days of the Great Eastern, rectangular flue boilers, with flat stayed surfaces were in vogue, with working pressures ranging from 15 to 25 pounds per square inch, while at the present time 180 to 200 pounds is the rule, 192 pounds being given as that adopted for the Oceanic.

Although the powering of the Oceanic is thus about double that of the Great Eastern, the increased economy of modern engines is such that the total fuel consumption should be decidedly lower. With simple engines and low pressure, six pounds of coal per h. p.-hour would have been a good result, while, if the performance of the quadruple-expansion high-pressure engines of the Oceanic does not show a consumption of less than two pounds, her builders will have good reason to be disappointed.

While no especial claims are being made as to the speed of the Oceanic, it is fully expected that she will make the run between Liverpool and New York within the seven-day limit from port to port, which means that, while on the high seas, a speed of 475 to 500 miles per day must be maintained, corresponding to a rate of about 18 knots. The speed of the Great Eastern, under favourable circumstances, was about 14 knots. Until practically a whole day can be knocked off the transatlantic record there is not very much use in endeavouring to exceed this speed, since the only result is that of requiring the arriving vessel to lie in harbour over night, the nominal gain being offset by the impossibility of landing passengers after nightfall.

Some especial features of the Oceanic may be noted here, although fuller information concerning the machinery is expected hereafter. All parts of the propelling machinery are practically doubled, thus enabling the ship to proceed, no matter what portion may fail. The thrust block, the main point of application of the propelling power, is duplicated for each engine, each thrust bearing being of sufficient capacity to receive the thrust of its engines. The main steam pipes are of welded steel, with butt straps riveted on, and the smaller pipes are of solid drawn steel.

Notwithstanding the experiences recently obtained with the Kaiser Wilhelm der Grosse, the Oceanic is not to be fitted with independent air-pumps; but the air-pumps are so arranged as to be operated by side levers from the main engines in the usual way, while the auxiliary machinery is of the usual type, and presumably of corresponding steam-consuming capacity. In these two latter features it is to be regretted that recent experiences have not been permitted to guide, but the considerations of certainty and convenience have been placed before that of operative economy, and, when the conditions of the service are taken into account, this is seen to have been probably the wiser course.

English and American Machine Tools.

A NUMBER of letters have recently appeared in the correspondence columns of *The Engineer* upon the well-worn subject of the relative merits of English and American machine tools, and while personal preferences doubtless entered into much of what was written, yet many of the questions are of immediate practical importance.

In the first place it appears that the real question at issue is not altogether the nationality of the tools, so to speak, but rather the importance of replacing antiquated tools by those of modern design and operation. As one of the correspondents well remarks: "We have many times seen machines which were in use 'many years ago in my father's time'—as we have been told—doing good work, and which, by the way, could have been done at one-third the price by adopting later methods." Such establishments certainly need modern tools and whether of English or American make matters little, as either would be a vast improvement over such antiquated equipment as is indicated by the reverence in which the tools of "my father's time" are held.

It is certain, however, that those English tool makers who maintain the excellence of English tools do so by showing the similarity of their products to those of the leading American builders, and in fact the principal difference between works equipped with English and American tools seems to be in the output of the machines. For this the workmen are doubtless largely responsible, since it seems very difficult to obtain even with American tools the same degree of production as is obtained with the same tools in the land of their origin.

It really seems as if most of the discussions which are held upon this question of different kinds of tools are rather at cross purposes, and that there is not much difference of opinion as to the value of automatic machines, specialised systems of manufacture and modern methods generally; all of these are understood to be good things, and more, as the only means by which foreign competition can be successfully met.

The real trouble lies in the fact that the equipment of existing works with complete modern plants means the immediate sinking of much which has been carried for many a long year as capital, and which can only be discarded at the risk of cessation of present dividends, and the possible requirement of assessments. It is difficult to see, however, what other alternative there is, and as matters look at present it seems as if the old establishments will either have to expend large sums in replacing their antiquated equipments, whether with English or American tools matters little, or else submit to be distanced in the competition either by home establishments of more enterprise or later origin, or by the pushing foreigner who is already well within the gates.

House-to-House Electric Distribution.

IT is interesting to observe the social effects that follow the introduction of a new power. Prior to the invention of the steam engine there were no great aggregations of workmen in factories where common sources of power were utilised; there were, indeed, but few applications of other power than that furnished by the muscular labour of men or animals,—save, perhaps, where a few water-wheels turned mills. Industries,such as weaving and spinning,were carried on in the houses of the workmen, and it was not until the superiority of power-driven machinery became manifest that the aggregations of workers and machines called factories came into being.

In the ribbon industry of France the patriarchal system of working is still in vogue. Each workman, or family of workmen, has his or its small ribbon-looms, the materials for weaving being supplied by a *fabricant*, who pays the workers when the ribbon is returned to him, a piece-rate for their labour. Until very recently these little looms have been driven by hand-power. While this arrangement served excellently to keep families together, so that the aptitude or taste of the younger members might be trained in the traditional way, it still left much to be desired, and, in the St. Etienne region, it seemed that the ribbon industry was doomed to extinction, or to the more economical collection of its members under factory roofs.

The divisibility and ready application of electric power have averted these calamities, according to a highly interesting note by M. Edouard Simon, in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale.* In the region referred to the factory has been actually spread out, by means of electrical power distribution, until it includes the houses of the workmen. The looms are driven by electric power generated at a common source, and this economy introduced into the industry has already shown its beneficial effect.

The system of distribution and utilisation of power is of interest. The first works were put in at 15 kilometres from St. Etienne, with three turbines of 300 h. p. each, and a reserve of two steam-engines of similar power. Not long afterward this installation absorbed another at Pont de Lignon, forty kilometres from St. Etienne, and since that time the united systems have served twenty-four villages through one hundred and ten kilometres of trunk-lines. Three-phase alternating current at 5,200 volts is generated directly at the dynamos and fed to the main transmission lines at that pressure. At thirty points transformer stations are installed, feeding motors in their vicinity with current at 190 volts and lights at 110 volts. In the town of St. Etienne there are installed, in addition, three steam-driven generating stations, distributing energy at 190 volts directly, to avoid the dangers of the high-tension used on the country lines. In all, the various stations aggregate the respectable figure of 2,200 h. p.,—about 2,500 ribbon looms, 8,000 incandescent lights, and 100 h. p. of motors being operated from the circuits.

The general conditions under which power is sold to the workmen are somewhat singular. There is no attempt at a meter system, contracts being made on a time basis. Each ribbon-loom requires about one-quarter horse-power for its operation, and for each a flat rate of ten francs per month is charged. Deductions for stoppages are made when notice is given to the station, provided the stoppage is forty-eight hours or longer. Stoppages due to failure of the current supply entitle the weavers to a proportionate reduction in the charges for power. The motors, if furnished by the weaver, must fulfil certain specifications, those of about five prominent makers being acceptable. The power company will, however, furnish motors and install them free of charge, for a rental of one franc per month per loom. Contracts for power are made for periods of four years, the prices of renewal at the expiration of this period to be the same or less.

"Thanks to this organisation, so minutely studied to fit the needs and the customs of the local industry, the double network of triple conductors ramifies all over the outlying quarters where the ribbon-weavers live. In some places the metallic conductors, suspended over the two sides of the road or the street, festooned from the many stories of the houses, crossing each other like gigantic spiders' webs . . . give a strange appearance to the sombre streets of high buildings with bare fronts.

"Other centres of production, where the work is equally a family matter, where little work-places distributed through country districts painfully struggle with foreign competition, may find, it seems, at St. Etienne valuable indications of methods to follow."

While this small beginning, in the centre of an old and established industry, is slowly establishing its value, it seems to point to a lesson that may be learned in many factory communities. The present system of gathering the machines and the power under one roof has compelled the workman to come to the factory; the electrical distribution method takes the factory to the home of the workman. In any industry where elements of artistic taste or traditional skill enter, as in the watch industry of Switzerland, this method of preserving the individuality of work, while avoiding the high costs of small and scattered prime powers, is admirable. It is another instance of the diffusive nature of electrical applications. The electric tramway has spread the area of towns, wherever introduced, and taken people further from their work; the distribution of power to them in their houses may still further check the centralisation that has begun to be so marked a feature of manufacturing towns. The social effect, and the effect upon the health of the community, of thus scattering aggregations of labourers can hardly fail to be most beneficial.

Automobiles in France.

UNTIL very recently France has held the leading position in the development of automobile vehicles, and, although other countries are now rapidly catching up to her, yet in the use of mechanically-propelled vehicles there is no doubt that more experience has been had in France than elsewhere.

For this reason an excellent review of the whole subject, in the form of a discussion by M. Barbet, in *La Revue de Mecanique*, of the motor vehicles shown at the exhibition recently held at the Tuileries, is worthy of notice.

It is only about four years since the modern revival of interest in mechanically-propelled vehicles for common roads began, although the idea of constructing such machines dates back to the invention of the steam engine, Watt having made the suggestion, and Cugnot having actually made an operative steam automobile in 1770.

Cugnot's machine was remarkably successful in practice,but was little more than a toy, and is still preserved as a curiosity in the Conservatoire des Arts et Métiers.

In England a number of well-designed steam coaches for common roads were built between 1820 and 1830 by Goldsworthy Gurney, to whom a memorial window may be seen to-day in S. Margaret's. Gurney's machines, being provided with excellently-designed water-tube boilers and judiciously-proportioned steam engines, were decidedly ahead of their time, and their use was abandoned.

The renewal of interest in automobilism is due doubtless to the general desire for travel, which has grown very much of late years; and the introduction of the bicycle as a general means of locomotion, and the enormous development of electric traction, have assisted in cultivating a demand for mechanical propulsion on common roads.

The early modern automobiles were provided with steam motors, the boilers being fired with petroleum, the most notable among these being the designs of MM. de Dion and Bouton, and M. Serpollet; but, after the invention of the light-weight high-speed petroleum explosion motors of

Daimler and Benz, general attention was drawn to engines of this type for motor vehicles, and the great success of the automobiles of MM. Levassor and Peugeot, at the trials between Paris and Rouen in 1894, and Paris and Bordeaux in 1895, established, in France at least, the superiority of the petroleum motor over the steam engine with petroleum-fired boiler.

The petroleum explosion motor, however, is probably only a temporary success, for the electric storage battery is very successful for motor cabs and pleasure vehicles, and steam appears to be the only motive power which can be depended upon for the so-called " heavy-weights," or merchandise and omnibus automobiles.

M. Barbet gives a great number of illustrations of the various types of vehicles exhibited at the Tuileries, but they show a general family likeness which renders the appearance and description monotonous. Most of them are curious hybrids between the work of the cycle factory and the carriage or wagon builder, with occasional glimpses of the product of the machine shop, and nearly all of them still contain ample evidence of the influence of the absent horse. In many cases in which there might be ample opportunity to enter the vehicle from the front, this most convenient mode of entrance, ordinarily obstructed by the horse, is now quite unnecessarily blocked by a useless dashboard with polished rod across the top for the support of the reins which are not there, the passenger being obliged to climb over wheels and mud guards while getting in from the side. In fact, nearly every carriage shows plainly that the body of the vehicle is but a crude adaptation of the old form.

A noteworthy exception to this crudeness is found in the work of the Maison Clement, in which, as might be expected, the lines of the bicycle are followed in the well-designed motor tricycles and quadricycles, while the Voiturette of the Compagnie Française de Cycles et Automobiles is another decidedly independent design.

The entire exhibition gives an excellent opportunity to see what has been done in France up to the present time, and, while many of the exhibits are good examples of what to avoid, the general result should tend to advance automobile construction.

Electric Traction in the Orleans Tunnel.

AFTER careful consideration of methods of tunnel-ventilation, the engineers of the Orléans railway have decided to adopt the radical method, suggested in these pages last month in connection with the Simplon tunnel, of using electric locomotives to haul trains through the subterranean part of the line, from the Place Valhubert to the Quai d'Orsay, in Paris.

The conditions of traffic on the new extension of the terminal line of this company lend themselves readily to electrical operation. Constrained by the growth of the city away from the location of its old station, the company found itself compelled to extend its lines to a point nearer the focus of things Parisian. Of the extension no less than 3,700 metres is tunnel, the terminal itself being below the ground-level and really a continuation of the subterranean works. The lighting of the tunnel required the establishment of a considerable electric station, and the application of electric power to trains on the terminal section required nothing more than an enlargement of this. The methods adopted are well chosen to meet the exigencies of the situation, being simple and such as have proven satisfactory in similar cases elsewhere. A description of the plans appears in *Le Génie Civil.*

At Ivry, more than five kilometres from the terminus at the Quai d'Orsay, three-phase current is generated at a frequency of 25 periods and a pressure of 5,500 volts. Three transforming sub-stations are in course of construction,—one at the generating installation itself, one at the old station, and the third at the new terminus. In each of the last two are groups of transforming mechanisms, one converting the three-phase high-tension current into direct current at 550 volts, for the operation of the electric locomotives; while the other, entirely independent of the first, converts to direct current at 500 volts for the five-wire lighting circuits. For the first transformation — that producing the railway power current—the conversion is accomplished by rotary converters of 250 kilowatts each, running at a rate of 500 revolutions per minute. Accumulators are to be connected across the terminal of these, and will serve to greatly reduce the sudden and great fluctuations of load that will arise from the intermittent train service.

In order to completely eliminate the influence of the power-demand from the lighting circuit, the latter is operated from direct-current dynamos direct-coupled to synchronous motors operating directly upon the 5,500-volt mains. Fluctuations in the voltage at the sub-stations, due to the movement of trains, will, naturally, have no effect upon the steadiness of operation of these motors, so long as the frequency of the circuit remains the same.

For reasons of economy and simplicity the lighting circuits are operated on the five-wire system, the outer wires being at a difference of potential of five hundred volts. To compensate any unbalancing of the system, equalisers are introduced across each division of the wiring circuits.

The electric locomotives will be eight in number, each having two four-wheel trucks, a motor being mounted on each of the four axles. Their general arrangements will be similar to those of the Hoboken and Baltimore locomotives. The normal power of each will be 500 kilowatts, and the weight 40 tons. This power and weight suffice for the tractive effort needed to start a 350-ton train on the 1.1 per cent. grade under the Place Valhubert.

No delay will be occasioned by the shunting of the steam locomotive and coupling on of the electric engine, or *vice versa*, since this will be always done during the train's stop at the old Austerlitz station. It is estimated that the total cost of the electric installation, comprising the power station, locomotives, and third-rail system, will be 3,058,000 francs, a moderate price to pay for the cleanliness and satisfaction that will attend its operation of such a system. The fine new terminal and tunnel might soon have become a foul and soot-blackened cavern, like too many termini in other cities; but this sensible move of the Orléans railway company has made it certain that its station will always be pleasant. In these days of competition among railway companies for suburban traffic the question of cleanly and airy termini is one which is assuming the very first importance. The new station in Paris seems to furnish a most attractive precedent for the consideration of railway companies elsewhere.

The Power of the Rhine in Switzerland.

In view of the announced determination of the cantonal government of Zurich to appropriate for the development of power the entire flow of the Rhine as it passes through the canton, a general view of the extent and possibilities of the enterprise, as given in an article in *Le Génie Civil,* is a matter of current interest.

By establishing hydraulic power stations at suitable points, it is expected not only that all the electric energy necessary for the cities of Winterthur and Zurich will be supplied, but also that numerous minor centres within a radius of twenty-five to forty kilometres will be reached, the whole scheme involving an expenditure of upwards of 25,000,000 francs.

The area drained by the Rhine as it flows between Schaffhausen and Bâle includes nearly two thirds of Switzerland, the remaining third consisting of the basins of the Rhone, the Ticino, and the Inn, these rivers flowing respectively towards the west, the south, and the east. Taking the average rainfall over the area drained by the Rhine, and allowing 60 per cent. for evaporation and absorption, it appears that the delivery of the river should be about 560 cubic metres per second,—a computation which agrees very well with gaugings made between Waldshut and Bâle, after the junction of the Aar, which brings in the waters of the Reuss and the Limmat.

Taking the normal flow of the river at the points where its utilisation is possible, the following table, condensed from one in the article referred to, shows the net power available on the turbine shafts at each point :

1. Falls of the Rhine (Laufen)	10,600 h. p.
2. Rheinau	6,500 "
3. Eglisau	8,000 "
4. Kaiserstuhl (Weiach)	5.500 "
5. Laufenburg	12,000 "
6. Rheinfelden	15,700 "
7. Aeugst	10,000 "
Total	58,000 h. p.

At present about one-half of the power is already utilised at the Falls of the Rhine at Laufen, while at Rheinfelden the entire capacity of the river will be used by the great power station now nearing completion. The energy developed by the proposed station at Aeugst is to be taken entirely in the city of Bâle.

Laufenburg is less favourably situated with regard to the supply of a large city, but, within reach of electrical transmission, there are a number of minor industrial centres which can be well supplied from this power station, although this plant is a matter for the future.

The present sources of power available for development by the cantonal government are those at Rheinau, at Eglisau, and at Weiach near Kaiserstuhl, in addition to the remaining half at the Falls of the Rhine. Where the river forms the boundary between two cantons, the power must be divided equally between them, the Falls of the Rhine and Eglisau being controlled by Zurich and Schaffhausen, while at Rheinau and at Weiach the power belongs to the canton of Zurich and to the Grand Duchy of Baden, and at Laufenburg and at Aeugst it is divided between the canton of Aargau and the Grand Duchy of Baden.

The manner in which the power is to be developed at these various stations is briefly indicated, and gives some idea of the extensive engineering works involved. At Laufen a tunnel is to be pierced through the rocks on the left bank of the Rhine above the falls, rendering the entire fall of 23 metres available; and, as the minimum discharge is 23 cubic metres per second, this will give, at an efficiency of 75 per cent., a net capacity of 5,300 h. p.

Below the falls at Laufen the river follows a winding course, without sufficient fall to enable any direct utilisation of its power, but, by the construction of a dam, and the boring of a tunnel to carry the water across a loop in the stream, a head of 7 metres can be obtained, which will enable 6,500 h. p. to be utilised at Rheinau, and at the same time leave a flow of 15 cubic metres per second to keep up a semblance of water in the Rhine between the intake and discharge of the tunnel.

At Eglisau and at Weiach dams are to be built, furnishing a fall of 7 metres at the former point and 4.50 metres at the latter, and an aggregate of 13,500 h. p. at the two stations. Each station is to be provided with a reserve of steam power to make up any deficiency in power which may arise in time of low water, it being estimated that about 25,000 h. p. of steam machinery will be installed for occasional use on this account.

Details of the electrical portion of the scheme are not given, but it is intended that a three-phase current at a pressure of 10,000 volts shall be used, being distributed to main centres and transformed to 3,000 volts, and then again distributed to local stations, at which a second reduction to 300 volts will be made, and the current delivered to the consumers.

The price which is to be charged for power varies according to the magnitude of unit, ranging from 500 francs per year for a single horse power to 160 francs per h. p. for 100 h. p., being about one-half the cost of steam power, based on the price of coal at Zurich or Winterthur.

If this important project is carried to a successful completion, it will afford a notable example of governmental development of natural resources, and also a remarkable illustration of the entire utilisation of an important river for power purposes over a stretch of more than one hundred and thirty miles.

Bridging the Rhine at Bonn.

DURING the past few years Germany has been especially active in the construction of important bridges, and in these columns notice has been given from time to time of the projecting and completion of important structures such as those at Düsseldorf, Müngsten, Worms, and Bonn.

The latter bridge, but recently finished, is an excellent example of a type of which the Düsseldorf bridge is also an illustration, consisting of a braced arch span of much greater rise than the roadway level, the latter being formed of a light truss suspended by rods from the ribs of the great arch above.

In the Düsseldorf bridge, the completion of which was noticed in these columns last month, there are two of these wide spans, each of 594 feet, while in the new bridge at Bonn, of which an excellently-illustrated account appears in the *Deutsche Bauzeitung*, there are one main central span of 614 feet, and two side spans of just half the width, or 307 feet each, together with a number of smaller masonry arches to form the approaches of each side.

This form of construction involved two main piers in the stream, and, fortunately for the conduct of the work, the conditions were favourable for satisfactory foundations. Beneath the river mud was found a bed of sand and gravel containing coarse pebbles, the whole forming a layer more than forty feet thick, under which was found a solid bed of clay. This enabled the foundations for the piers readily to be constructed of concrete within coffer-dams, the coffer-dams being formed upon rolled-steel sections, which were driven through the gravel and sand until the clay was reached, and then filled with concrete. The concrete was made with Portland cement, to which trass was added, in order to hasten the setting.

When the foundations were completed, the vertical steel members of the coffer dam were cut off below the water-line. This difficult operation was performed by the use of electric drills, holes being drilled close enough together to enable a definite fracture to be made.

The general construction of the superstructure, which was executed by the Gutehoffnungshütte, calls for no especial comment, but it is interesting to note that electric power was used wherever possible, a temporary electric power plant being set up, and electric cranes and other applications of electric power being installed.

As at Düsseldorf, the general computations and proportions of the arches were under the charge of Professor Krohn, of Sterkrade, while the somewhat elaborate ornamentations of the railings and portals were due to the architect, Bruno Mohring, of Berlin.

Germany now possesses two important and interesting structures in these new Rhine bridges, and it is more than probable that similar designs will be adopted for wide-span bridges at other points where the low grade will not permit the use of the more desirable high-level arch.

The Refrigerating Plant of the Vienna Markets.

It has been asserted that the most important invention of man is that of artificial light, doubling the possible length of the operative day; close upon this in importance, however, must be classed those inventions which give us control of temperature by production of heat and cold. There is every probability that in the immediate future much of the effort of human energy will be directed toward equalising the variations of natural forces, one result of which will doubtless be the general introduction of artificial cooling for many purposes to which it is not now applied.

In a recent issue of the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines* is given an illustrated account of the interesting plant installed in the great market buildings at Vienna, which, though there are other and as important plants elsewhere, possesses features that render it worthy of notice.

As the plant is intended merely to maintain a low temperature without reaching the freezing-point, thus providing storage rooms cool enough to insure the proper preservation of meats and other market articles, and at the same time avoiding the objections of too low a temperature, the indirect system is adopted, cooled air being distributed through the storage chambers by a forced circulation.

The refrigerating machines used in this especial case operate with carbonic acid gas, the gas being compressed to liquefaction and the heat of compression removed by water, after which the liquefied carbonic acid is permitted to expand again to the gaseous state in coils placed in tanks of brine, the brine thus being lowered to the desired temperature, while the expanded gas is returned to the compressors to complete the cycle. It is evident that any of the accepted forms of refrigerating machines might be used in this manner, the choice depending upon local conditions.

The cold brine, instead of being circulated through coils of pipe in the storage chambers, is permitted to flow over a series of pans or trays arranged in layers in a special chamber, and the air is drawn through the spaces between the trays and thus cooled before being delivered to the storage vaults. The circulating fan, placed at one end of the chamber in which the cooling trays stand, draws the air from the storage rooms through the spaces between the trays and delivers it again into the vaults, the same air thus circulating continuously, in a direction opposite to that of the cold brine over the trays.

The effectiveness of this method of cooling for the maintenance of a moderately low temperature, without permitting the freezing-point to be reached, is well shown in a graphical record giving the maximum and minimum external temperatures for the entire year from April, 1897, to April, 1898, together with the corresponding slight variation which took place in the storage vaults. A temperature from 1° to 5° C. was maintained with a remarkable degree of steadiness during a period in which the external temperature varied between +35° and —5° C.,—a result so very satisfactory that the system is to be extended to additional market storage vaults in Vienna.

The original paper, which is from the pen of Herr Joh. Hermanek, gives in tabulated form some valuable data concerning the performance and efficiency of this plant, and many points of value which cannot be detailed here are described and illustrated at length, making the whole a valuable contribution to this branch of engineering.

Electric Tramways in Germany.

THE *Elektrotechnische Zeitschrift*, gives, as is usual at the beginning of the year, a review of the growth of electric tramways in Germany, and this exposition of the growth of electric traction in the German empire during 1898 shows that the rate of progress of the past few years has been fairly well maintained. The tabulated statistics bring the precise data only to September, but, as this was also the date for previous years, the comparison can be made, and the amount of completed construction at the close of the year can be estimated very closely.

Among other interesting facts it is shown that on September 1, 1898, there were 68 cities in Germany in which electric tramways were in use, as against 56 in the previous year,—an increase of more than 21 per cent.; but this is not so correct a measure of the progress of the work as is obtained from some of the other figures, the total mileage having been nearly doubled (49.4 per cent.), the number of motor cars having been increased by 41.5 per cent., and the capacity of the power stations being 33 per cent. greater in 1898 than in 1897. Taking into account the works in progress, there are 77 cities in Germany in which electric traction is in operation, with a total mileage of 963 miles, or, measured as all single track, 1,250 miles.

Among the larger cities may be noted Aachen, Braunschweig, Chemnitz, Dresden, Hamburg, Hanover, Leipzig, Munich, Stettin, and Stuttgart, all of which are rapidly becoming filled with complete tramway systems covering practically their entire area; while in Berlin, Breslau, Cassel, Köln, Frankfurt, and Konigsberg, the conversion of horse tramways to roads operated by electric power is rapidly going forward.

The total capacity of the dynamos used for electric traction in Germany is now 33,333 kilowatts, not including storage batteries equivalent to 5,118 kilowatts, thus giving a total of 38,451 kilowatts. Taking the data of 44 tramways, the average powering per kilometre is 20.7 kilowatts, or 33.3 kilowatts per mile, while for the same roads the powering per car averages 14.2 kilowatts.

Nearly all the tramway systems operating in Germany use the overhead trolley, the only underground conduits being on short lines in Berlin and Dresden. In some cities the so-called mixed system, using overhead conductors in connection with accumulators, has come into use, especially in large cities in which the overhead trolley is objectionable in certain portions. Such combinations are in use in Berlin, Dresden, Hagen, and Hanover, while in seven cases pure accumulator traction is used.

The data concerning the various electric tramways in Germany are tabulated with German thoroughness in the article referred to, and a study of the tables will furnish valuable material for the prosecution of other installations. The tables contain information as to the grades, length and gauge of tracks, and number of motors and their capacity, together with a quantity of miscellaneous data concerning the power plants, and other useful information.

While Germany has undoubtedly done well in increasing her electric tramway mileage from 600 to more than 1,200 miles in one year, she is yet far from being fully equipped with local electric transportation facilities.

In comparison with the United States, with their 15,672 miles of track, the work which has yet been done in Germany is only a beginning, the total tramway mileage in Germany being somewhat less than that now in operation in the state of Ohio alone.

In view of what remains to be done, not only in Germany, but in other parts of the continent, as well as in England, the published data of existing tramways should serve only as incentives to engineers and electricians to push forward and develop a field which is so important, and as yet so far from being occupied.

Colliery Explosions.

A very interesting question has been brought forward by the disastrous explosion in the Carolinenglück mines (Westphalia), where 120 men perished, the greater number of them asphyxiated at points as far as 1,000 metres from the focus of the explosion. In the *Revue Universelle des Mines*, Herr Franz Büttgenbach, discussing the explosion, which was due to suspended coal-dust, suggests that the ventilation of mines may be too energetic, and that the forcing of volumes of air into the workings after such an explosion may simply mean the carrying of the deadly carbonic oxide, remaining as a product of the actual explosion, to remote workings.

In the disaster referred to, the men who were killed were at great distances from the scene of the explosion, and their bodies bore no marks of mechanical injury. The energetic ventilation of the mine seems to have thoroughly spread the gaseous products of combustion, the more readily because the shock of the explosion had destroyed the partitions and doors in the mine which served to direct the currents of air. In less than ten minutes the workings were full of air charged heavily with carbonic oxide, the result being the appalling fatality noted above.

Another point urged by the author is that the strong currents of air due to a too-powerful ventilation dry the dust of the mine, especially that lodged in the upper parts of the galleries and on the timbering, and that no amount of sprinkling will reach that. There is thus maintained a fruitful source of danger. While it is admitted that forcible ventilation is the best means of ridding the workings of fire-damp and floating dust, it is equally certain that the ill effects of drying the deposited dust and spreading the gaseous products of a localised explosion may fully counterbalance all the merits of energetic circulation of air.

THE AMERICAN PRESS

Review of Leading Articles

The Civil Engineer and Public Health.

THE close relations existing between the occurrences of daily life and the work of applied science are becoming more and more generally appreciated, and in no branch of engineering science is this relation more apparent than in the department of sanitation.

In an address, lately delivered before the Engineers Club of St. Louis, and published in the *Journal of the Association of Engineering Societies*, Professor J. B. Johnson discussed the subject of the civil engineer as a guardian of public health, and outlined this important relation of a large portion of the profession to the public in a very interesting manner.

The fundamental care of health, in so far as it consists in the fighting of disease, is undoubtedly the function of the physician, but when the question of prevention is considered, the work of the engineer must be the main reliance of the community.

The growth of the science of bacteriology, which may be said to have commenced with the introduction of vaccination by Jenner, in 1798, has demonstrated that all infectious or contagious diseases are caused by taking into the system either in the air we breathe, in the water we drink, or in the food we eat, pathogenic, or disease-producing, bacteria.

" As soon as this is admitted it becomes somebody's duty to look well to the elimination of these ailments by preventing their causes from reaching their natural prey. On reflection it will be found that the carrying out of these preventive measures devolves largely upon the civil engineer, and furthermore, he is called upon to determine what measures will prove at once most economical and most effective in preventing the spread of these fatal maladies."

Notwithstanding the important relation which the engineer thus bears to the vital question of public health, there is evidently insufficient interest taken in the subject by a large proportion of the profession. It is this point which is especially emphasized by Professor Johnson, and, holding as he does, that the provision of the means of prevention of disease falls within the sphere of duties of the civil engineer he maintains that it is the further duty of the engineer " to inform himself thoroughly as to all the causes and remedies and to lead in the work of educating the public to the point of providing legislation and funds to carry out such measures and to build such works as are required."

Professor Johnson calls attention to the fact that less than 3 per cent. of the membership of the American Public Health Association is composed of engineers, practically all the rest being physicians, while we should expect to see an association devoted to the prevention of disease mainly composed of bacteriologists and sanitary engineers rather than of physicians. It is greatly to the credit of the medical profession and to the discredit of the engineering profession that the reverse is the case.

It is solely the engineer's business to provide the drinking water, to dispose of all sewage and garbage wastes, to make healthful streets and alleys, and to keep them clean. The business of heating, lighting, and ventilating large assembly halls, hospitals, school buildings, and railway stations and cars is also now coming to be regarded as the business of engineers, and soon the artificial cooling of such buildings will be added to their duties. The census reports show that one death in every seven is caused either by a diarrheal disease or by typhoid, malarial, or intermittent fevers, and nearly all these deaths are known to be caused by impure drinking water. In the year 1890 over 120,000 persons died in the United States of these diseases, and without doubt we may charge this number of deaths to the use of impure water.

According to the laws of many states, the value of a life is placed at $5000, thus making the money value of the lives thus unnecessarily sacrificed equal to more than $6,000,000 annually, and, as Professor Johnson points out, it would cost very much less than this amount to provide preventive means against such loss.

The means of preventing the spread of disease through drinking water is a rational or scientific filtration, such as has now been shown to be effective. The means of prevention of disease from the decay of organic matter caused by bacterial parasites is to remove immediately all organic wastes from the confines of the city. The rapid and thorough removal of street accumulations means a smooth, clean, and impervious pavement, and the wooden pavement so common in many large cities is most unsanitary so soon as it has begun to decay. Again, the elementary and fundamental principle of sewerage is not only to move all filth off as quickly as possible, but when it is started it should be kept moving until it passes into some large river or goes to some kind of purifying terminus. The relations of sources of water supply to methods of sewage disposal should also be considered in this connection, so that in all these problems, so vitally connected with the prevention of disease and the guardianship of public health the engineer stands before the physician, and if the former knows what to do, and is given means and opportunity for doing it, the latter would be far less busy in curing diseases which should not have been permitted to exist.

The New South Terminal at Boston.

THE new South Union Railway Station, of the Boston Terminal Company, which has just been opened, is much the largest railway station in the world, having about double the capacity of any other. Descriptions of it have been published in several of the American railway and engineering journals.

The Railroad Gazette says: "Entering at the main entrance, at the corner of Cove and Summer streets, we pass at once, without steps and with an imperceptible rise of about 3 feet in 100, into the great 'midway' lying across the ends of the stub tracks. . . The surface stub tracks, twenty-eight in number, and at a grade of five feet above the sidewalk outside, are arranged in pairs, with a passenger platform to each pair, and between the pairs are seven platforms devoted exclusively to the trucking of baggage and express matter, which serve fourteen tracks and are reached by electric truck-lifts from a subway under the tracks leading from the baggage-room. The train shed is in three spans, with a roof of one sweep."

The total frontage of the building on three streets is 2,190 feet, the main front being 875 feet long and five stories high. The entrance is a thoroughfare 92 feet wide, lined with polished granite. Its ceiling is of white enameled bricks, with steel girders encased in white marble. The outward baggage-room is 26 feet wide and 562 feet long. Opening towards the "midway" are eleven ticket-windows while sixteen more open into the waiting-room, affording ample facilities for the booking of passengers.

The immense waiting-room, 225 feet long, 65 feet wide, and nearly 30 feet high, is a feature of the design of the station. The women's waiting-room is 34 by 44 feet, and is provided with lounges, and even with cradles for children.

The power and other engineering equipments of the station are on the same elaborate scale. Among them are provisions for heating and lighting, ice-making, air-compressing, water-filtering and cooling, fire-protection, pumping, and for preventing the freezing of the leaders which carry away water from the immense roof and train-shed areas. All the switches and signals about the station are operated by compressed air. Some of the signals are located on the ground, but most of them are on nine signal-bridges, varying in span from 50 to 120 feet. On the easterly side of the yard is a building, 460 by 40 feet, which contains the power plant for all services. No less than nineteen electric elevators are in the buildings.

The provisions for heating and ventilating are on a scale commensurate with other features of the building, nearly 5,000,000 cubic feet of space being enclosed. Air is forced in by electrically propelled fans in the cellars and driven out by similar exhaust fans in the attics. All the lavatory ventilating system is distinct from that for other parts of the building. The ice-making plant has a capacity of twenty tons per day.

Special precautions were necessary for the disposal of water, as all the suburban loop-tracks, and a number of the basements, are below tide-level. A large sump was built near the power house, into which the whole of the track surfaces, etc., are drained, and from which a centrifugal pump removes the water. As there are some fourteen acres of roofs from which storm-water and melting ice and snow are to be carried away by many conductors, the prevention of the freezing of the latter was a problem of the first order. It has been solved by special provisions for the application to them of steam and hot water.

At the old stations which are to be consolidated in this new structure there have been about 4,000 train movements in 18 hours of each day. It is believed that the arrangement of tracks at the new station is simple, and ample for this purpose.

Some further dimensions may be of interest, as showing the great size of this important station. The main building is 850 by 725 feet in plan and 135 feet high. The train-shed is 602 feet long and 570 feet wide, having three spans, of which the central one is 228 feet. About 2,500 tons of rails are used in the fifteen miles of tracks comprised in the terminal. Four miles of these tracks are under roofs.

The Regulation of the Mississippi.

THE report of the U. S. Senate Committee on Commerce upon the subject of the regulation of the Mississippi river, of which a very full abstract is given in the *Engineering Record*, contains much interesting matter about the floods in the great river, and the means which are being taken for its control and regulation.

The regulation of the Mississippi has two great ends in view; one, the prevention of damage from the overflow of low-lying country at certain points along its course, the other, the improvement of its navigation by providing a channel of sufficient depth for the draught of such vessels as the demands of commerce may require.

The principal territory affected by floods consists of certain basis or bottoms along the banks of the river between Cairo and Forts Jackson and St. Philip, there being six of these basins, with an aggregate area of 29,790 square miles.

Ever since the settlement of these portions of the valley of the river there has been a constant struggle to reclaim these basins, but the work is as yet only partially accomplished.

The floods which cause the overflow of these basins are due to a combination of causes, the principal source being the Ohio river, from which the spring floods from the crest of the Alleghanies bring a great volume of water at a time when the normal rise of the lower Mississippi brings the river almost to the danger line. With this is combined the heavy rainfall over the swamp region along the Mississippi from the mouth of the Ohio to the Gulf of Mexico, as well as the later rise of the upper Mississippi, which serves to prolong the floods.

The upper portion of the river is measurably controlled by reservoirs, but neither on the Ohio nor on the lower Mississippi are there suitable locations for reservoirs, and it appears that the cost of this method of regulating the river would be far greater than the construction of embankments, or levees along the entire front of the basins.

Levees have been constructed along the river at various points ever since 1717, and the history of the river from that time has been a record of construction and breaks, with many floods and the incurring of much damage. The construction of the levees has gradually extended, having been undertaken by riparian owners, then by parishes or counties, then under the authority of states, and finally by the general government, and although the work which has been done by the states and the general government has been conducted in an entirely harmonious manner, yet it is evident that the river cannot be properly and entirely controlled, so far as floods are concerned until an entire system of levees constructed as a whole by the general government is executed.

It is estimated that such a system, from the head of the St. Francis Basin to the Head of the Passes, at a grade sufficiently high and strong to afford complete protection against floods at the highest probable stages, would cost from $18,000,000 to $20,000,000, and that it would take four to five years for its completion. Such a system is recommended in the report, and the saving of life and property which it would cause, seems an ample warrant for its construction.

So far as navigation is concerned, the chief reliance for obtaining a low water navigable channel seems to be dredging, and with the improved hydraulic dredges, excellent results have been obtained. At the passes, forming outlets into the Gulf, jetties, dykes, and dams have proved effective, and these supplemented by dredging have given the best results at least cost.

There seems to be little doubt that the recommendations of the Senate committee, based as they are upon the experience of the engineers who have been fighting the great river through some of its most disastrous floods, should be carried out with energy and unity of purpose, and that sporadic and local attempts should give way to a determined effort to execute a complete and systematic plan for the regulation of the stream from the mouth of the Ohio to the Gulf of Mexico.

Street-Railway Mileage and Capitalization in the United States.

No industry is more peculiarly American than the electric street railway. The prodigious and astonishing growth of this industry since its beginning, eleven years ago, to the present, and the rate at which it is now increasing, are both well shown in an elaborate tabulated statement published in the *Street Railway Journal.*

The total mileage of street railways in the United States at the beginning of this year was 17,291, of which 15,672 miles were operated by electricity. During 1898 the increase in total mileage was 1,573 miles, while the increase in miles of electric railway tracks was 1,997,—the apparent discrepancy being due to the decreasing mileage of cable and horse railways. The percentage proportion of the various kinds of street-railway systems, estimated on a mileage basis, is as follows: electric, 90.6 per cent.; horse, 3.8 per cent.; cable. 2.9 per cent.; miscellaneous systems, 2.9 per cent. Comparing the mileages at the beginning and end of 1898, the electric systems show a growth of 12.2 per cent., the cable mileage has decreased 14.7 per cent., and the horse mileage has decreased 31 per cent., while miscellaneous systems, such as steam and oil motors, have increased their mileage 8.15 per cent.

These figures show the enormous preponderance of electric systems; but perhaps the most illuminating statistics are those relating to the capital investment in these traction enterprises. In the tables referred to there is no differentiation between electric and other systems as regards the capital represented, but the insignificant proportion invested in horse, cable, and other miscellaneous systems makes no great difference in the result. The increase of investment in 1898 amounted to the enormous total of $142,610,025, while the grand total of capitalization reaches the amazing figure of $1,621,820,894. No less than 54,529 cars are in circulation upon the tracks of the various systems. Of the fifty States and territories seven have no street railways. Of the forty-three possessing tramway systems ten—New Hampshire, Vermont, Rhode Island, Connecticut, Delaware, Maryland, Michigan, Idaho, and Utah—have no horse-car lines.

On another page is a review of a recently-published table of similar statistics relating to the German empire, in which it is stated that there are in operation in that country 1,250 miles of electric-railway lines. Five of the States surpass this figure,—Massachusetts, New York, Pennsylvania, Ohio, and Illinois,—New York alone having 1,862 miles in operation.

A Gigantic Power Plant.

THE central power plant for the Third Avenue Railroad Company's lines in New York will be the largest single aggregation of electric power-generating machinery ever constructed. A recent number of the *Electrical Engineer* contains a preliminary account of this last and largest enterprise in electric traction.

The generating units will be sixteen in number, each consisting of an engine of 4,000 h. p., economic rating, direct-coupled to a polyphase-current dynamo of 3,000 kilowatts' capacity. This will give the station a nominal capacity of 64,000 h. p., or a maximum capacity of about 100,000 h. p. The engine room will be 320 feet long. In the adjacent boiler house the 30,000 h. p. of water-tube boilers will be arranged in two rows on each of two stories, while over all a great coal-bin will be erected. From this bin the coal will be fed directly by chutes into automatic stoking-machines. Ashes will be automatically withdrawn from below the boilers. Both natural and forced draft will be used in connection with four tall steel stacks. All the condensing apparatus will be concentrated into a central plant, by which the engines will be served in sections. Most elaborate provisions have been made for handling this part of the plant with economy and reliability.

A separate isolated plant will supply electric light to the building and adjoining premises, while provisions have also been made for fire protection, a cooling system, oiling system, coal- and ash-conveyors, and the other numerous appurtenances of so large a project. About one hundred miles of track, some of it among the busiest in the city, will be served from this station, while a part of its surplus energy will be used for the charging of the accumulator omnibuses, which the company expects to introduce in Fifth avenue.

There will be some very interesting questions in connection with the operation of this enormous plant. Probably there has been no attempt before to work such a number of polyphase generators—certainly not those driven by steam-engines—in parallel. If this cannot be accomplished successfully, as some engineers believe, the advantages of consolidating this great mass of generating machinery under one roof are, for the most part, lost. A fuller description of the plant, with details of the methods for engine-governing, will be of great interest, for the project appears to have been well studied in its details. The sub-station system will be used for the conversion of the polyphase current into that needed for the propulsion of the cars, but no details regarding the methods to be employed have been given out. The necessity for paralleling the direct-current sides of these also introduces some rather difficult problems, especially if rotary converters are to be used.

Electric Vehicles and Central Stations.

THE rapid advance of the electric automobile introduces a new element for the consideration of those interested in electricity supply stations, on account of the almost immediate possibility of these vehicles offering a remunerative day-load. The problem of securing a day-load for such stations has been long considered, and its solution is most desirable from the station manager's point of view, because the equipment of the generating plant must be sufficient to carry its maximum load,—coming on only for a few hours each day,—while, during the rest of the time, the machinery needed to provide for the maximum demand is idle. Interest and depreciation costs are never idle, however, and mount up as rapidly while the machinery is standing still as when it is running.

In a paper read before the Northwestern Electrical Association, at Milwaukee, Mr. H. M. Maxim gives the results of investigations undertaken to discover the probable future usefulness of these vehicles as a source of demand for electrical energy. He discusses the cases of delivery-wagons, such as are used by large retail establishments, and of omnibuses and cabs. While the wagons of a single large concern are apt to be sent out according to a definite schedule, thus causing the demand for power for charging to fall between certain definite hours, this would not be the case with vehicles from a number of smaller establishments,—the class of custom most likely to be found in practice. In the operation of cabs and omnibuses the demand for power can be so regulated as to furnish an almost ideal day-load. Taking the case of a recently designed omnibus system, having nine vehicles running under a headway of five minutes, Mr. Maxim shows that the power-demand would be constant between narrow limits,—880 and 930 amperes,—and that such a system would be an admirable customer for an electricity supply station.

"The demand for omnibus service in many places, especially in certain regions where, for æsthetic reasons, the trolley line is excluded, is without doubt a real one, and will, within the next twelve months, call for the equipment of many such lines. Their success in many instances must rest, in a measure, upon the coöperation which the central-station owners afford, and it would seem that the desirability of increasing the day consumption of power, and the ultimate immensity of this demand, would invite their most favorable attention. The consumption of day-loads by electric vehicles offers such manifest advantages that the lowest possible rate should be made this class of of customers for the encouragement of the industry and from considerations of its coming importance."

Sand Filtration.

THE question of pure water supply is one which must be met by every municipality, and unless the locality is so exceptional as to have a natural supply of uncontaminated water, some artificial means must be adopted, either to bring pure water from a distance or to purify that which is nearer at hand.

In a paper by Mr. R. S. Lea, recently presented before the Canadian Society of Civil Engineers, upon the purification of public water supplies by sand filtration, the more recent installations of this method of purifying water are described at length, and much useful information is given.

That some such method of obtaining a pure water supply must ultimately be adopted in the great majority of cases is daily becoming more apparent. No matter how pure the source may have been when first utilized, and no matter how far it may originally have been situated from causes of contamination, it is practically impossible to maintain the condition by which alone purity is secured. Even could contamination be prevented, the increasing demand for pure water by rapidly growing cities constantly involves the development of additional supplies and these are naturally increasingly difficult to obtain.

Pure water is naturally preferable to purified water but "water whose natural state is above suspicion is often exceedingly difficult to procure except at a cost which is practically prohibitive. Consequently many cities and towns, especially the larger ones, are forced to use such waters as may be practically available, and to make the best of them."

"This best is by no means to be held lightly, since by modern methods of sand filtration it is possible to so change the nature and characteristics of polluted water as to convert it to the appearance, taste, and probably absolute wholesomeness of the most innocent of mountain torrents."

Water supply may be derived either from ground waters or from surface waters, the former being subjected to such a rigorous process of natural purification as to place them beyond the need of any artificial treatment, while the latter are nearly always polluted to a greater or less extent. The nature of the pollution may be that unavoidable in any stream, such as discoloration by swamp drainage, turbidity from clay and other suspended inorganic-matter, or development of algæ and other minute water plants, or it may be the far more dangerous pollution due to the reception of human sewage.

These questions should in every case be determined by thorough chemical and biological examinations before any attempts are made to devise systems of purification, always bearing in mind that it is in connection with the organic matter in water, dissolved or suspended, visible or invisible, that serious pollution from a sanitary standpoint is to be apprehended.

Assuming the presence of organic matter of an objectionable character, the method of purification must be considered, and it is to this portion of the problem that the greater part of Mr. Lea's paper is devoted.

When the first attempts at water purification were made, very little was known of the organic matter in solution, and the object aimed at was simply the clarification of the water, or the removal of suspended matter visible to the eye. It was for this purpose that the first sand filter was constructed by Simpson, in London, in 1839, the water being passed through a layer of about six feet of sand and gravel, the result being very satisfactory. With such filters it was found that the surface of the sand became gradually obstructed by the formation of a layer composed of the material removed from the water, and when the water failed to pass the filter it became necessary to remove the deposit.

When the development of the science of bacteriology demonstrated that it was to the presence of certain of these microscopic organisms that dangerous pollution of water was due, it was at first supposed that filtration would be powerless to remove them.

"How," it was asked, "can filtration affect substances dissolved in water? And as for the minute organisms found in putrescent bodies, they could pass a hundred or a thousand abreast through the interstitial spaces of ordinary sand as used for this purpose." Nevertheless it was found that the sand filter did remove 97 to 98 per cent. of all the germs contained in the water, and, with the modifications and improvements made over the earlier forms, it can now be depended upon to remove from .99 to 100 per cent. of the germs.

While there is even yet some difference of opinion as to the precise *rationale* of the efficiency of the sand filter, there is no doubt that it is due to the formation of an organic layer or mantle of a jelly-like nature on the surface of the sand, together with the deposit of a coating of the sand grains with a film of the same gelatinous organic material for a considerable depth below the surface.

Details of the construction of numerous installations of sand filters, both in the United States or Europe are given by Mr. Lea, and the results of experience, as most fully exhibited, demonstrate the entire practicability, both from a scientific and a commercial standpoint, of this method of obtaining a pure water supply from any available stream or lake.

"If a proper valuation is put upon the lives saved by its use, the construction of a filter plant is often in the long run a source of economy. Such considerations, however, seem quite unnecessary. A city water supply should be pure, wholesome, attractive in appearance, just as the streets should be clean and well paved, and the public buildings architecturally beautiful. Besides, having gone to the expense of obtaining a public water supply, indifference with regard to its purity, or unwillingness to provide for it would seem to be utterly unreasonable, especially when it can be secured for such a comparatively small increase in the total cost as sand filtration involves."

Train Resistance.

NUMEROUS attempts have been made to devise a formula from which the resistance of a railway train may be computed when the speed and weight are given, but the problem has been found almost as elusive as the not dissimilar one of the derivation of a formula for the velocity of the flow of water.

In a recent issue of the *Street Railway Journal*, is given the latest effort to solve the problem of train resistance, and a formula, derived by Mr. John Lundie using a new method of investigation, is given together with a table of comparisons with the results of actual tests, showing the degree of accuracy which may be expected from its application.

The method hitherto followed for finding train resistance has been that of computing from indicator cards the power developed by the locomotive when drawing a train at a constant speed over a level track; with an arbitrary allowance for engine friction. The difficulty of finding long distances of straight track, and of maintaining uniform speed has made this method unsatisfactory, and hence Mr. Lundie has attacked the problem in another manner.

Instead of measuring the resistance directly from the power required to haul the train, he determines it by an examination of the speed curves of a train when coasting from any speed to a dead stop. By adopting this method it is possible not only to obtain the gross resistance due to track and journal friction and air resistance combined, but also to differentiate between the air and the friction elements.

By taking the results from more than 150 runs made with trains of different weights on the South Side Elevated Railroad of Chicago, points were plotted in a graphic form, and it appears that these points cluster closely around "straight-line curves" and also that these lines intercept each other at a single point situated at a definite distance above the origin.

From this it is to be seen that the resistance should be expressed by an equation of the first degree, the location of the point common to all the lines giving the minimum possible train resistance for all speeds and weights. This minimum resistance appears, by Mr. Lundie's diagram to be four pounds per ton, and it is interesting to note that in none of the recorded experiments so far made on passenger or freight trains of all weights, has the resistance been less than this figure.

Mr. Lundie's formula is as follows:

$$R = 4 + S\left(0.2 + \frac{14}{35 + T}\right)$$

in which

$R =$ resistance in pounds per ton.

$S =$ speed in miles per hour.

$T =$ the weight of the transportation unit in tons (2000 lbs.).

While this formula is empirical in so far that it has been deduced from the results of experiment, yet it is rational in form and in the manner of its deduction, and appears to rest upon a sound mathematical basis.

It is well said that the test of any formula lies in its application, and Mr. Lundie's formula appears to check very well with the Stroudley, Sinclair, and Dudley tests of train resistance as collated by the late Mr. Wellington, as well as with later experiments made on the Philadelphia and Reading Railroad and on the Central Railroad of New Jersey. Since the tests from which the formula was deduced were all made upon trains of 20 to 100 tons, and for speeds from five to thirty miles per hour it is very satisfactory to find that it agrees within about 5 per cent. for trains of 100 to 300 tons and for speeds up to 70 miles per hour.

The Franklin Institute.

THE completion of the seventy-fifth year of the existence of the Franklin Institute renders a brief notice of the work of this important scientific institution timely, especially as its true position is often misunderstood by those not familiar with its purposes and workings.

Both in its regular meetings and in the meetings of the various sections of specialists, the Franklin Institute affords opportunity for the presentation of subjects in nearly every line of scientific research, with the assurance that intelligent and exhaustive discussion will be given and the results of experience elicited.

When any subject is deemed worthy of elaborate investigation and report it is referred to a sub-committee chosen from such members as may be deemed especially qualified to examine it, and in this manner very many inventions, processes, and suggestions have been given exhaustive study at the hands of experts whose services might not otherwise be available.

The Franklin Institute also renders an important incentive to investigators by the award of medals and premiums for meritorious work in various lines of research and invention, being in this respect not unlike the French *Société pour l'Encouragement de l'Industrie Nationale*, and the awards of the various medals in the control of the Institute are eagerly sought by inventors in all lines of industry.

THE ENGINEERING INDEX

INTRODUCTORY

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20c. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

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Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents: thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10c. per month, or $1.00 a year; to non-subscribers, 25c. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m* a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill=Illustrated; W=Words; Anon=Anonymous.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. della Societa d. Ing. e d. Arch. Ital. Rome. *b-m.*
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Jour. *m.* London.
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg-und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am. Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S.A.R
Colliery Guardian. *w.* London.
Commerce. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, New York.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.

Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, O.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs. and Surveyors. Peoria, Ill.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour N. E. Waterw. Assoc. *qr.* New London, Conn.
Journal Political Economy. *qr.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kans.
La Ingenieria. *m.* Buenos Aires, Argentina.
L'Energie Electrique. *w* Paris.
Locomotive. *m* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, O.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *qr.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revista de Obras Publicas. *w.* Madrid.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines, *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerische Bauzeitung. *w.* Zürich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Düsseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Terrestrial Magnetism. *qr.* Cincinnati, O.
The House Beautiful. *m.* Chicago, Ill.
The Mechanical Engineer. *w.* Manchester.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York.
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Locomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Cathedral.

The Cathedral of Troja. William H. Goodyear. Illustrates and describes very interesting details. 4200 w. Arch Rec—Jan.-March, 1899. No. 25520 C.

Churches.

Elements of Church Architecture. Part first considers the origin of the Christian churches. Ill. 700 w. Ill Car & Build—Jan. 6, 1899. Serial. 1st part. No. 25295 A.

Colonial Architecture.

Good and Bad Colonial Architecture. Clarence H. Blackall. Critical review of examples of this class of architecture of both early and recent types. Ill. 4000 w. Arch Rev—Vol. VI, No. 1—Jan., 1899. No. 25360 D.

Competition.

The Pennsylvania State Capitol. A brief history of the competition to furnish plans, its abolition, and the result. 1600 w. Eng Rec—Jan. 21, 1899. No. 25349.

Exposition.

Progress of Work on the Champs-Elysées Palace of the Exposition of 1900. (Le Grand Palais. Chantiers de Construction.) A. da Cunha. Illustrated description of methods of work on this building. 2000 w. La Nature—Dec. 3, 1898. No. 25400 B.

High Buildings.

The "Sky-Scraper" Up to Date. Montgomery Schuyler. A critical review of many prominent buildings in New York, with fine illustrations. 6300 w. Arch Rec—Jan.-March, 1899. No. 25519 C.

Hospital.

The Lady Dufferin Victoria Zenana Hospital, Calcutta. Plans and drawings with description. 1000 w. Ind Engng—Dec. 17, 1898. No. 25367 D.

The Loomis Sanitarium. Illustrated description of a hospital for consumptives. 600 w. Eng Rec—Jan. 14, 1899. No. 25239.

Hotels.

Hotel Design. T. Raffles Davison. Part first illustrates a New Forest hotel—the Crown Hotel of Lyndhurst. 2000 w. Brit Arch—Jan. 6, 1899. Serial. 1st part. No. 25300 A.

House Planning.

House-Planning from the Aesthetic Point of View. H. H. Statham. Read at meeting of the Archt. Assn., London. On the importance of symmetry and a clear plan in securing effect. A comprehensive paper, illustrated by examples. Also discussion. 13500 w. Builder—Jan. 14, 1899. No. 25517 A.

Metal Framework.

The Morton Building, New York City. Illustrated description of cast-iron column framing with novel connections for girders. 800 w. Eng Rec—Dec. 31, 1898. No. 24988.

Municipal Architecture.

Municipal Architecture in Boston. A statement of the results of the present plan of obtaining designs for civic buildings and the proposed amendments. 1000 w. Eng Rec—Jan. 14, 1899. No. 25232.

Opera Comique.

The New Opéra Comique, Paris. Brief description with illustration. 700 w. Builder—Jan. 7, 1899. No. 25315 A.

Palace.

The Rococo Palace of Wilhelmsthal. (Rococo-Schloss Wilhelmsthal.) With interior views and details of this rococo palace of the middle of the 18th century. 3500 w. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1899. No. 25489 D.

Restaurant.

The New Poodle Dog Restaurant Building. Illustrates and describes a newly erected building in San Francisco. 3000 w. Cal Arch't—Dec., 1898. No. 25019 C.

Spires.

Notes on the Theory of Cupola and Spire Construction. (Beitrag zur Theorie der Kuppel und Turmdächer.) R. Kohfahl. A discussion and criticism of the recent paper of Prof. Müller-Breslau on the same subject, with diagrams showing methods of resisting wind pressure. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 17, 1898. No. 25461 D.

Theatre.

The New Royal Theatre at Wiesbaden. (Das Neue Königlichen Theater in Wiesbaden.) With elevation, plans and section of this handsome theatre. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 6, 1899. No. 25478 B.

HEATING AND VENTILATION.

Church.

Ventilating and Heating of a Newark church. Illustrates and describes a system with some direct radiation, supplemented by a heated fresh air supply intended to furnish one-third the total heat. Circulation of air in the church is obtained in an unusual manner. 1400 w. Eng Rec—Dec. 31, 1898. No. 24990.

Disk Fans.

Some Formulas for Disk Fans. J. H. Kinealy. Paper presented at the New York meeting of the Am. Soc. of Heat & Ven. Engs. Formulas deduced by the writer for determining the proper number of revolutions, and the number of cubic feet of air a disk fan could be expected to deliver per minute. 1200 w. Eng News—Jan. 26, 1899. No. 25545.

Gas Warming.

Battery Gas Heaters. (Batterie-Gasöfen.) P. Schroeter. Describing improved forms of gas radiators for warming, including devices for control of temperature and for the removal of products of combustion; also data as to efficiency. 2500 w. Gesundheits Ingenieur—Dec. 31, 1898. No. 25485 B.

Heating Practice.

A Comparison of British and American Heating Practice. D. M. Nesbit. Compares the hot-water methods and the steam as practiced in Great Britain and in the United States. 4200 w. Dom Engng—Jan., 1899. No. 25501 C.

Residence.

Heating a Private Residence with a Warm-Air Furnace. B. Harold Carpenter. Condensed from a paper presented at the New York meeting of the Am. Soc. of Heat & Ven. Engs. Illustrates and describes arrangements for overcoming the weak points in warm-air furnaces. Discussion. 1100 w. Eng News—Jan. 26, 1899. No. 25549.

Heating a Residence. Describes and illustrates a combination system, providing for simultaneous heating by warm air and hot-water circulation. 1800 w. Met Work—Jan. 21, 1899. No. 25359.

School Heating.

Ventilation and Heating of the Melrose, Mass., High School. Illustrated description of a hot-blast system with the engine using steam at the same pressure (15 lbs.) employed in the coils. 2000 w. Eng Rec—Jan. 7, 1899. No. 25104.

Warehouse Heating.

Heating of the U. S. Appraisers' Warehouse. Illustrated description of a direct-radiation plant using the vacuum return system. 1500 w. Eng Rec—Jan. 21, 1899. No. 25358.

MISCELLANY.

Abbey.

Llanthony Priory. Historical description with illustrations. 3800 w. Builder—Jan. 7, 1899. No. 25316 A.

Architecture.

The Position of Architecture Among the Fine Arts. Report of the discussion on Edwin T. Hall's paper read before the Architectural Assn. 3000 w. Builder—Dec. 24, 1898. No. 25044 A.

Country Estates.

The Development of a Country Residence and Stable. Illustrated account of the water supply, sewage, lighting and stable accommodations. 2400 w. Eng Rec—Jan. 28, 1899. No. 25588.

Derrick.

An Extension Tower Derrick. Illustrated description of plant used satisfactorily on several high buildings in New York. 1200 w. Eng Rec—Jan. 7, 1899. No. 25102.

Dublin.

The Architecture of Our Large Provincial Towns. Historical and descriptive account with many fine illustrations. 14,500 w. Builder—Jan. 7, 1899. No. 25313 A.

Exposition.

Moving the 30-Metre Gallery of the Champ-de-Mars. (Déplacement de la Gallerie de 30 mètres au Champ-de-Mars.) Ch. Dantin. Illustrated description of the method used in moving the large steel framework of one of the old exposition buildings to a new site. 3000 w. Le Génie Civil—Dec. 17, 1898. No. 25409 D.

Fire Proof Construction.

Description of Fire Test of a Ten-Inch Hollow Flat Arch, Made by Maurer & Son, New Jersey. Gustav Liebau. The test was carried out on a building of brick erected for the purpose. Ill. 800 w. Brick—Jan., 1899. No. 25249.

Fireproof Construction of Buildings in the United States. R. W. Gibson. A discussion of the fire-resisting building methods in use in the United States, and the materials which have proved most satisfactory, with related matter of interest. Discussion. Ill. 11,700 w. Jour Roy Inst of Brit Archt's—Dec. 10, 1898. No. 25069 B.

The Tall Building Under the Test of Fire. H. de B. Parsons. A well illustrated paper dealing with the dangers of fire in high buildings, especially as exemplified in the case of the Home Life Insurance building in New York, and with the questions of so-called fire-proof construction and isolated fire-fighting plants. 4800 w. Engineering Magazine—Feb., 1899. No. 25438 B.

Fireproofing Wood.

See Military Engineering.

History.

Choisy's History of Architecture. R. S. Critical review of a recent work very favorable to the writer. 3500 w. Arch Rev—Vol. VII, No. 1—Jan., 1899. No. 25361 D.

Interiors.

Bricks and Tiles for Interior Finishing. Russell Sturgis. The article sets forth the sanitary and artistic possibilities of these materials, giving many suggestions for their use. Ill. 3000 w. Br Build—Jan., 1899. Serial. 1st part. No. 25606 C.

London Improvements.

The Proposed London Improvements. Text of the bill promoted by the London Council, which defines the nature and extent of the proposed improvements. 1800 w. Builder—Dec. 31, 1898. No. 25165 A.

Manchester, Eng.

Development of Manchester. E. Salomons. An address at a meeting under the auspices of the Manchester Soc. of Archts., on the development and suggested improvements. Brief discussion. 2400 w. Arch, Lond—Dec. 30, 1898. No. 25166 A.

Painting.

Sanitary Painting. A. G. White. An address delivered at the convention of the Master House Painters of England and Wales. On the sanitary, æsthetic and protective value. 2200 w. Jan. 6, 1899. No. 25312 A.

Roman Palace.

The Palace of the Cancelleria at Rome Not Designed by Bramante. Alfredo Melani. Considerations are presented based on examination of style, in part first. 1700 w. Am Arch—Jan. 21, 1899. Serial. 1st part. No. 25375.

CIVIL ENGINEERING.

BRIDGES.

Arch.

A Park Bridge. Illustrated description of a masonry arch in Central Park, New York, built under supervision of architects and an engineer. 400 w. Eng Rec—Jan. 21, 1899. No. 25351.

A Private Park Arch Bridge. Illustrated description of a concrete-steel bridge on the Vanderbilt estate, at Hyde Park, N. Y. 600 w. Eng Rec—Jan. 14, 1899. No. 25238.

The Theory and Design of the Masonry Arch. William H. Burr. A study of the stability of the arch, and methods of determining the pressures to which it is subjected. Diagrams. 6500 w. Sch of Mines Qr—Nov., 1898. No. 25197 D.

Bridge Failure.

The Cornwall Bridge Accident. A description of conditions before and after the accident, and an explanation of the cause. Ill. 1500 w. Eng News—Dec. 29, 1898. No. 24948.

The Wilson Avenue Bridge Disaster, Cleveland, O. An illustrated explanation of the cause and nature of the wreck of this bridge. 900 w. Eng News—Jan. 26, 1899. No. 25551.

Bridge Removal.

Rapid Bridge Moving. Presents further information concerning the bridge removal at Milwaukee. A 130-ton draw span was moved 219 ft. down the river to a new site, and located there ready for use in less than 3 hours. 700 w. Eng Rec—Jan. 21, 1899. No. 25355.

Removing a Bridge. Illustrates and describes the removal of a draw span over the Kinnickinnic river at Milwaukee, Wis., to a new site. 1000 w. Ry Age—Jan. 13, 1899. No. 25264.

Bridge Test.

Test of a Bridge to Destruction. An account of the test to destruction on a Vierendeel bridge in the Tervueren Park, on the occasion of the Brussels International Exhibition, held in 1897, and the conclusions drawn. The bridge was a type between a plate and lattice girder. Ill. 3300 w. Ry & Engng Rev—Jan. 7, 1899. No. 25179.

Drawbridges.

Some Interesting Types of Modern Drawbridges. Frank W. Skinner. Brief illustrated description of various types of drawbridges and their manner of operation. 2000 w. Harper's Wk—Jan. 28, 1899. No. 25518.

East River Bridge.

The New East River Bridge. Illustrated description of the progress of the work on this bridge at New York, with information concerning the plan and construction. 1800 w. Sci Am—Jan. 7, 1899. No. 25038.

Erection.

The Erection of the Attok Bridge, India. Illustrated account of the erection of three spans of 250 ft., and two of 300 ft. by means of lofty timber corbels. 800 w. Eng Rec—Jan. 28, 1899. No. 25582.

Highway Bridge.

Concrete and Expanded Metal Highway Bridge Construction in Allegheny County, Pa. Illustrates two methods of employing this material. Both bridges described are near Pittsburg. 600 w. Eng News—Jan. 26, 1899. No. 25542.

Melan Arch.

The New Bridge at Steyr. (Die Neue Schwimmschulbrücke in Steyr.) Describing a recently constructed bridge of 138 feet span, on the Melan principle of iron beams imbedded in concrete. The arch is hinged at the crown and springings. 3500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Dec. 23, 1898. No. 25474 B.

Plate-Girder.

Long Span Plate-Girder Bridge. Illustrated description of a railway span 105 ft. long and 9½ ft. deep, at Bridgeport, O. Explains both design and erection. 1000 w. Eng Rec—Jan. 14, 1899. No. 25236.

Pony-Truss.

Standard Plans for 120-ft. Pony-Truss Bridges, Northern Pacific Ry. Illustrates and describes the novel features of the pony trusses used. 900 w. Eng News—Jan. 5, 1899. No. 25029.

Rhine.

The New Bridge Over the Rhine between Bonn and Beuel. (Die Neue Rheinbrücke zwischen Bonn und Beuel.) An excellent illustrated description of this latest bridge over the Rhine. The central braced arch has a span of 614 feet. Three articles, 5000 w. Deutsche Bauzeitung—Dec. 24, 28, 31, 1898. No. 25452 each B.

Riveted Spans.

A Strong Though Damaged Bridge. Illustrated description of a 115 ft. heavy riveted lattice bridge, which permitted the passage of a heavy freight train after it had been severely injured. 600 w. Eng Rec—Jan. 21, 1899. No. 25350.

Short Span.

Construction of Short Span Railway Bridges. Henry Goldmark. Review of the fundamental principles governing the construction of culverts, arches, and truss bridges less than 175 ft. long. 3300 w. Eng Rec—Dec. 31, 1898. No. 24986.

Suspension.

A New Suspension Bridge at Niagara. Illustrates work and describes a new bridge in process of erection from near Lewiston, N. Y., to a point on the Canadian side, just above the village of Queenston, Ont. 1100 w. Ry Age—Dec. 30, 1898. No. 25002.

Highway Bridge Over the Argen at Langenargen. (Strassenbrücke über die Argen bei Langenargen.) Detailed description with numerous illustrations of a suspension road bridge of 220 feet span over the Argen in Bavaria. 1000

w. Zeitschr d Ver Deutscher Ing—Jan. 7, 1899. No. 25470 D.

The Old and New Suspension Bridges Over the Niagara River at Lewiston, N. Y. Interesting accounts of these bridges, with illustrations. 2000 w. Eng News—Jan. 12, 1899. No. 25185.

Vauxhall.

New Vauxhall Bridge. A short description of the structure now being demolished, and an illustrated description of the new concrete arch bridge. 1200 w. Builder—Jan. 7, 1899. No. 25314 A.

Viaduct.

The Viaduct Over the Rhine at Eglisau. (Der Rhein-Viadukt bei Eglisau.) A fully illustrated description of this new viaduct, including the construction of the tall piers and masonry arches of the approaches, and the false works and details of the central truss; also graphical records of the deflections under test. Two articles. 3000 w. Schweizerische Bauzeitung—Dec. 17, 24, 1898. No. 25492 each B.

CANALS, RIVERS AND HARBORS.

Blasting.

Rock-Blasting Under Water. The methods employed in such work are described, and operations in the East River, N. Y., on the Danube, Rhine, &c., mentioned. 1400 w. Sci Am Sup —Jan. 7, 1899. No. 25040.

Canal Restoration.

Thames and Severn Canal. Brief account of the work of restoration recently completed. 800 w. Engr, Lond—Dec. 23, 1898. No. 25064 A.

Dam Failure.

The Destruction of a Dam at Tampa. Illustrated description of a dam failure caused by a dynamite explosion. 500 w. Eng Rec—Dec. 31, 1898. No. 24985.

Dismal Swamp.

Dismal Swamp Canal. An account of the reopening of this canal which connects the Chesapeake Bay with Albermarle Sound, and its importance as an inland waterway. 1800 w. Bos Jour of Com—Jan. 28, 1899. No. 25591.

Dortmund Canal.

The Harbor of the King Ludwig Works at Bruch. (Die Hafenanlage der Gewerkschaft König Ludwig zu Bruch.) A description of the harbor plant on the Dortmund-Ems Canal for the handling of coal and coke in connection with the Westphalian mining district. 2500 w. Glückauf—Jan. 1, 1899. No. 25495 B.

Dredgers.

The Conversion of the "Wenlock" from a Bucket to a Sand-Pump Dredger. A copy of the specification with illustration. 1800 w. Ind Engng—Dec. 3, 1898. No. 25141 D.

Flood Discharge.

Capacities for Culverts and Flood-Discharge. Abstract of a paper by George Chamier, presented at a recent meeting of the Inst. of Civ. Engs., London. Gives a formula proposed for average cases, with the results of tests. 1200 w. Eng News—Jan. 26, 1899. No. 25550.

Flood Discharges. George Chamier. An elaborate review of the run-off from different areas and a new formula for estimating it. 4500 w. Eng Rec—Jan. 21, 1899. No. 25353.

Hamburg.

The Recent Development of the Harbor of Hamburg. (Die Neuere Ausgestaltung der Hamburger Hafenanlagen.) A review of the growth of the commerce of the port of Hamburg from 1882 to 1895, showing the development due to improved facilities. 4000 w. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1899. No. 25490 D.

Levees.

Levees, with Special Reference to the Red River System. Frank M. Kerr. The geographical position of Red River and some of its general features are given, with an account of the work in progress and its aim. 7000 w. Jour Assn of Engng Soc's—Dec., 1898. No. 25576 C.

Mississippi.

The Mississippi Floods, Their Cause and Prevention. The full text of the report of the Committee on Commerce, of the United States Senate, prepared with unusual care after consulting many experienced engineers. 6500 w. Eng Rec—Jan. 28, 1899. No. 25587.

The Mississippi River Floods and Methods for Their Control. From the report of the Committee on Commerce of the U. S. Senate. An examination of the causes, and necessary protection for property. 2400 w. Eng News—Jan. 26, 1899. No. 25543.

Nicaragua Canal.

Preliminary Report of the Nicaragua Canal Commission. Gives full text of this report, with brief comment. 1100 w. Eng News—Jan. 5, 1899. No. 25030.

The Nicaragua Canal in Congress. Editorial discussion of the amended bill as passed by the U. S. Senate. 2400 w. Eng News—Jan. 26, 1899. No. 25546.

Panama Canal.

General Abbot on the Panama Canal. Full text of the report presented to the U. S. Congress. 5500 w. Eng Rec—Jan. 14, 1899. No. 25235.

The American Isthmus and the Interoceanic Canal. W. Henry Hunter. A finely illustrated and complete description of the Panama canal, the plans of its engineers, present status of the work and future prospects. 5500 w. Engineering Magazine—Feb., 1899. No. 25434 B.

Regulating Streams.

The Regulation of Torrents and Mountain Streams. (La Sistemazione dei Torrenti e dei Bacini Montani.) A summary of Italian legislation on this point, now becoming very important in Italy. 1500 w. Giorn dei Lav Pubb e delle Str Ferr—Jan. 11, 1899. No. 25420 B.

Water Measurements.

Low Water Measurements in the State of California During the Summer of 1898. J. B. Lippincott. Tabulated summary of work and explanation of its value. 700 w. Eng News—Jan. 12, 1899. No. 25186.

Waterways.

Harbor and Waterway Engineering for 1898. A summary of the events of the past year in the United Kingdom showing great activity in this field. 4400 w. Engr, Lond—Jan. 6, 1899. No. 25273 A.

The Waterways of Russia. C. H. Moberly. An illustrated description of the waterways, excepting the Volga which has been previously described. 2800 w. Engng—Jan. 13, 1899. Serial. 1st part. No. 25381 A.

IRRIGATION.

Chinese Works.

Irrigation in the Celestial Empire. Illustrated account of Chinese works 2,000 years old which are constructed and maintained in an unusual, though successful, manner. 1400 w. Eng Rec—Jan. 28, 1899. No. 25583.

Irrigation Studies.

Stream Gagings and Other Studies Relating to Irrigation in Wyoming. Elwood Mead. Extracted from a forthcoming annual report. A statement of the conditions of streams and the influence of subterranean waters. 3500 w. Eng News—Dec. 29, 1898. No. 24949.

MISCELLANY.

Addresses.

Addresses Delivered at the Meeting to Commemorate the Semi-Centennial of the Boston Society of Civil Engineers, November 11, 1898. Gives the opening address by Howard A. Carson, president of the society ; and the historical address by Desmond Fitzgerald, past-president. 7500 w. Jour Assn of Engng Soc'y—Dec., 1898. No. 25574 C.

Buckling.

Eccentric and Axial Resistance to Buckling. (Exzentrische und Zentrische Knickfestigkeit.) A. Ostenfeld. An analytical investigation, taking into account the formulæ of Euler, Johnson, and Rankine, and comparing these with the experiments of Tetmaier. 7500 w. Zeitschr d Ver Deutscher Ing—Dec. 31, 1898. No. 25467 D.

Graphical Investigation of the Buckling of Straight Columns. (Graphische Untersuchung der Knickfestigkeit Gerader Stäbe.) Luigi Vianello. With numerous diagrams showing the method of computing graphically the bending moments under various conditions. 7500 w. Zeitschr d Ver Deutscher Ing—Dec. 24, 1898. No. 25464 D.

Cement.

Tests of Frozen Cement Mortar. Report of numerous experiments by Arthur G. Fogg, showing freezing is not injurious under certain conditions. 2000 w. Eng Rec—Dec. 31, 1898. No. 24984.

The Fine Grinding of Portland Cement. David B. Butler. Describes a large number of experiments to determine the effect of fine grinding. 1500 w. Eng Rec—Jan. 28, 1899. Serial. 1st part. No. 25585.

Drafting.

Drafting Rules for Structural Iron Work. Illustrated reproduction of the instructions of the Pittsburg Bridge Co. to its draftsmen. 4800 w. Eng Rec—Jan. 14, 1899. Serial. 1st part. No. 25237.

Earth Resistance.

The Testing of Earth Resistance. (Beitrag über die Bodenuntersuchung.) Describing a method of determining the density of earth by pressure of weights upon a sharp wedge ; data being thus obtainable for estimates of cost of excavation. 1000 w. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1899. No. 25491 D.

Examinations.

Grading Engineers by Examinations. Editorial review of the results of examinations conducted by the Institution of Civil Engs. and by civil service boards in the United States. 1800 w. Eng Rec—Dec. 31, 1898. No. 24981.

Highways.

A Russian Military Highway. Marsden Manson. An account of the road over the Caucasus. 800 w. Eng Rec—Jan. 28, 1899. No. 25586.

Metal Protection.

The Protection of Metal Work. A. H. Sabin. A lecture delivered at the University of Wisconsin. Gives rules for the best results and for good, but less thorough work. 1600 w. Eng Rec—Jan. 7, 1899. No. 25101.

Piers.

Difficult Pier Construction, Manhasset Viaduct, Long Island R. R. William A. Cattell. Illustrates and describes an unusual piece of work which caused much anxiety and expense. 900 w. Eng News—Jan. 12, 1899. No. 25184.

Public Works.

The Civil Engineer and National Public Works George Y. Wisner. A discussion of the gradual passage of public works from civil to military control, giving the history of the change and considering its wisdom. 4500 w. Jour Assn of Engng Soc's—Dec., 1898. No. 25578 C.

Reenforced Concrete.

The Influence of Metallic Reënforcement upon Mortars and Cements. (Influence des Armatures Métalliques sur les Propriétés des Mortiers et Bétons.) M. Considère. An account of some experiments showing unexpected strength in samples of reënforced concrete. 2700 w. Comptes Rendus—Dec. 12, 1898, and Jan. 2, 1899. No. 25418 each D.

Review.

Civil Engineering. Editorial annual review of work, events, and undertakings in this field. 7500 w. Engr, Lond—Jan. 6, 1899. No. 25274 A.

Sanitary Engineering.

The Civil Engineer as a Guardian of the Public Health. J. B. Johnson. The paper aims to show that it is duty of civil engineers to provide clean streets, pure water, and the quick removal of refuse and waste, and to lead in forming public sentiment to secure these results. 4500 w. Jour Assn of Engng Soc's—Dec., 1898. No. 25577 C.

Shield Driving.

A Wooden Lining for Shield-Driven Tunnels. Illustrates and describes methods used in the construction of the sewerage system of Melbourne, Australia. 1000 w. Eng News—Dec. 29, 1898. No. 24944.

Structural Materials.

Durability of Structural Materials. A. H. Sabin. On what the durability depends, with special discussion of iron and steel. 1500 w. Wisconsin Engr—Jan., 1899. No. 25206 D.

Vienna.

The Oldest Plan of Vienna. (Der Aelteste Plan von Wien.) Siegmund Wellisch. A description of the so-called Albertin map of Vienna made in 1438, valuable both for historical reasons, and also as the earliest known example of municipal surveying. Comparisons with succeeding surveys are given. 3500 w. Zeitschr d Oesterr Ing Arch Ver—Dec. 30, 1898. No. 25476 B.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

American Coal.

American Coal in Marseilles. A report giving information concerning a market for this product, most favorable to its introduction. 500 w. U. S. Cons Repts, No. 336—Jan. 28, 1899. No. 25580 D.

American Commerce.

The Promotion of American Commerce. Full text of the considerations presented by Jacob H. Gallinger, of New Hampshire, in respect to senate bill No. 5024. 3300 w. Naut Gaz—Jan. 26, 1899. Serial. 1st part. No. 25527.

Argentina.

English and American Trade in Argentina. F. C. Chappell. Presents facts concerning English and American trade with suggestions helpful to American exporters. 1200 w. Am Mach—Jan. 5, 1899. No. 25081.

Bourse.

America's Great Bourse. W. J. Casey. An account of the Philadelphia Bourse and its benefit in the business development of the nation, noting its principal features. 2000 w. Mfrs Rec—Jan. 20, 1899. No. 25331.

China.

American Trade and Policy in China. Information and suggestions from a personal letter to the editor, with comments. 1500 w. R R Gaz—Jan. 6, 1899. No. 25076.

Trade with China. Charles Denby, Jr., in the *N. Y. Journal of Commerce*. A reply to an article of Worthington C. Ford, in the Sept. number of the *Atlantic Monthly*, presenting statements showing the opportunities for American enterprise in this field. 1800 w. Bos Jour of Com—Jan. 7, 1899. No. 25144.

United States' Trade with China in Iron and Steel. Indications of soon becoming a large market for these products. 1500 w. Am Mfr & Ir Wld—Jan. 13, 1899. No. 25244.

Commercial Traveling.

Commercial Traveling in South America. William E. Torrens. Comments and suggestions from an observant traveler. 1700 w. Nat Assn of Mfrs, No. 29—Jan. 16, 1899. No. 25327.

Competition.

America and Germany as Export Competitors and Customers. Louis J. Magee. This paper, the first of a series, deals with the importance of industrial exports and the desirability of national recognition of this importance. 3400 w. Engineering Magazine—Feb., 1899. No. 25437 B.

American Competition with British Industries. Extracts from the *Glasgow Herald*, with comments. 1800 w. U. S. Cons Repts, No. 324—Jan. 14, 1899. No. 25243.

Some Notes on American Manufactures. J. Grant Birch. Part first considers some of the characteristics of American manufactures as compared with English, and mentions the labor conditions that impressed him during a recent visit. 1600 w. Engng—Dec. 16, 1898. Serial. 1st part. No. 25207 A.

Customs.

Customs Invoices in Canada. Copy of a circular issued by the Canadian customs, regarding invoices for customs entry under the general tariff. 2200 w. U. S. Cons Repts, No. 326—Jan. 17, 1899. No. 25265 D.

Duties.

Rate of Duty Imposed on Iron and Steel by Leading Foreign Countries. Compiled by James M. Swank. Part first reports Great Britain, France, Germany, Sweden, and Russia. 1700 w. Am Mfr & Ir Wld—Jan. 20, 1899. No. 25399.

Exporters.

Bolts and Nuts in England: Mistakes of United States Exporters. Comments from British papers on the disparity between English and American prices, with remarks on the mistake of underselling to the extent of demoralizing prices. 2000 w. U. S. Cons Repts, No. 319—Jan. 9, 1899. No. 25130 D.

Failures.

Failure Statistics—Their Meaning and Utility. The year 1898 shows the smallest in number and liabilities in the United States since 1892. Reviews the effects of conditions prevailing and gives tabulated statements for comparison. 7500 w. Bradstreet's—Jan. 21, 1899. No. 25366.

French Iron Trades.

"Temporary Admissions" in the French Iron and Steel Trade. J. W. Root. States the conditions in France which handicap her iron and steel industries, explaining the admission of foreign imports under name designated, and the working up of this semi-raw material. 2200 w. Ind & Ir—Dec. 30, 1898. No. 25162 A.

Germany.

Foreign Commerce and Industrial Progress in Germany. A review of the year 1897-98, showing the general prosperity of German industries, and giving information of interest relating to the foreign trade of the country. 3800 w. U. S. Cons Repts, Vol. LIX—Jan., 1899. No. 25027 D.

Iron Ore Trade.

Thirteenth Annual Review of the Lake Superior Iron Ore Trade. Horace J. Stevens. Report of large output and small profits, giving much information. Also discusses the prospects for the coming year. 2200 w. Am Mfr & Ir Wld—Jan. 6, 1899. No. 25178.

Iron Trade.

Pittsburg Iron Trade in 1898. Report concerning pig iron, plates, sheets, and other finished materials, with general remarks. 2200 w. Ir Trd Rev—Jan. 5, 1899. No. 25085.

The Chicago Iron Trade in 1898. George W. Cope. General review of the trade, with a partial record of prevailing prices. 4500 w. Ir Age—Jan. 5, 1899. No. 25015.

The Competition for Iron and Steel Markets in 1898. Statements based on figures from official reports of various countries showing progress or regress of exports, and comparisons showing that the progress made by the United States has surpassed all others. 2800 w. Ir Age—Dec. 29 1898. No. 24962.

The French Iron and Steel Trade in 1897. Statistics from recent returns of the foreign commerce of France. 2000 w. Ind & Ir—Dec. 23, 1898. No. 25054 A.

The Pittsburg Iron Trade in 1898. Robert A. Walker. An interesting review of the year, dealing with production, foreign trade, new construction, combinations and trusts, and the outlook. 7400 w. Ir Age—Dec. 29, 1898. No. 24961.

Japan.

Trade Conditions in Japan: Opening for American Goods. Extracts from the annual report of Consul Lyon. The peculiarities and prejudices that affect trade, and brief consideration of certain exports and imports. 2200 w. U. S. Cons Repts, Vol. LIX—Jan., 1899. No. 25023 D.

Leather.

Leather Manufactures in Germany. Reports the striking progress in the tanning and leather industries, and gives suggestions for American shoe manufacturers, for increasing trade. 1800 w. U. S. Cons Repts, No. 320—Jan. 10, 1899. No. 25146 D.

Liverpool.

Trade of Liverpool with the United States. From the annual report of Consul Boyle, of Liverpool. An account of trade in general and of particular lines; of Canadian competition, &c. 2400 w. U. S. Cons Repts, No. 315—Jan. 4, 1899. No. 25011 D.

Machinist's Hardware.

Screws, Nuts and Bolts in Foreign Countries. Consular reports from various parts of Europe giving information relative to the manufacture and trade in these products. Calls attention to the fact that Withworth's standard thread is so generally used as to make it useless to attempt to introduce any other system. 9000 w. U. S. Cons Repts—Vol. XV, 1898. No. 25021 D.

Mexico.

Commerce and Industries of Mexico. Extract from report of Consul-General Barlow. Information relating to climate, agricultural and other products, imports, exports, &c., &c. 3000 w. U. S. Cons Repts, No. 313—Dec. 31, 1898. No. 24964 D.

Oil Trade.

The Growth of Our Oil Trade. William Gilbert Irwin. A detailed account of the opening and production of the oil fields of the United States. 2500 w. Sci Am—Jan. 14, 1899. No. 25190.

Para.

Commerce of Para. Information from the annual report of Consul Kenneday, on the expansion of trade, in classes of goods furnished by the United States, and the opportunities. 4800 w. U. S. Cons Repts, Vol. LIX—Jan., 1899. No. 25025 D.

Prices.

Staple Prices Highest for Five Years. Statements regarding the Dec. prices, showing them to be at a higher level than at any time since 1893. 600 w. Bradstreet's—Jan. 14, 1899. No. 25228.

Rebates.

Rebates on Imported Goods in Cape Colony. A copy of the schedule reducing the rebate on imported goods passing through the colony to the inland states. 3000 w. U. S. Cons Repts, Vol. LIX—Jan., 1899. No. 25024 D.

Review.

The Iron and Steel Trades in the United Kingdom in 1898. General review of the conditions, output, rates, charges and imports. 10,000 w. Ir & Coal Trds Rev—Dec. 30, 1898. No. 25161 A.

Russia.

Suggestions Concerning Trade with Russia. Information of value to exporters, showing the opportunities for United States trade and the best methods of extending the market. 2500 w. U. S. Cons Repts, No. 325—Jan. 16, 1899. No. 25196 D.

Shipping.

Ocean Shipping and the Export Trade. Willard S. Mattox. On the importance of providing for the movement of American goods to foreign ports. 1800 w. Ir Age—Jan. 12, 1899. No. 25211.

South Africa.

British vs. American Goods in South Africa. Extract of an article from the *British and South African Gazette*, in reference to preference in South Africa for American goods, with the editor's comments. 3000 w. U. S. Cons Repts, Vol. LIX—Jan., 1899. No. 25022 D.

South Wales.

The Recovery in South Wales. On the remarkable recuperative power of the coal and iron trades. 1200 w. Engr, Lond—Jan. 13, 1899. No. 25391 A.

Statistics.

The Business Year. Statistical summary showing the commercial, industrial and financial results of the year 1898. 6800 w. Bradstreet's—Dec. 31, 1898. No. 24953.

Steel Trade.

The Future of the South Staffordshire Iron and Steel Trades. H. Le Neve Foster. Extract from presidential address, considering the manner in which further progress could be made in the Midlands, and noting many points of interest. 2000 w. Col Guard—Jan. 13, 1899. No. 25389 A.

Tariff Changes.

Proposed Tariff Changes in Belgium. Gives a copy of the project of law relative to the collection of duty on goods taxable ad valorem. 900 w. U. S. Cons Repts, No. 335—Jan. 27, 1899. No. 25579 D.

Trusts.

Can Consolidation Be Regulated by Law? Editorial advising the passing of a law requiring reports to be published of the business of all incorporated companies. 1400 w. Ir Age—Jan. 12, 1899. No. 25212.

Turkey.

Commercial Conditions in Turkey. Information of interest to exporters of American goods. 2500 w. U. S. Cons Repts, No. 318—Jan. 7, 1899. No. 25131 D.

Venezuela.

Cotton Goods Trade of Venezuela. William Whittam, Jr. Investigations and observations of a manufacturer and mill engineer, with comments on the commercial conditions of the country. 9500 w. Nat Assn of Mfrs, No. 28—Jan. 5, 1899. No. 25326.

Warehouse.

Need of an American Warehouse in China. Urging the need of an exposition in China to extend the American trade, and discussing the peculiarities of the people which must be understood in carrying on trade. 1000 w. U. S. Cons Repts, No. 316—Jan. 5, 1899. No. 25012 D.

CURRENCY AND FINANCE.

Loans.

Foreign Loans in China. Prescribing the necessary course to be pursued in contracting foreign loans for opening mines and constructing railroads in China. 800 w. U. S. Cons Repts, No. 332—Jan. 24, 1899. No. 25395 D.

Monetary Commission.

The Final Report of the Monetary Commission. Frederick A. Cleveland. An examination of the "facts and arguments" presented in this report, affirming that the arguments do not justify the conclusions, and the facts presented are inadequate. 8000 w. An Am Acad—Jan., 1899. No. 25001 F.

Money.

The Functions and Qualities of Money. Charles A. Conant. The subject is treated from the standpoint of the evolution of money, tracing the growth from the barter of primitive times to the mechanism of the modern exchange, with a glance at the possibilities of the future. 6000 w. Bankers' Mag, N. Y.—Jan., 1899. Serial. 1st part. No. 25218 D.

GOVERNMENTAL CONTROL.

Patent Rights.

The Nature and History of Patent Rights. E. L. Thurston. A consideration of those rights respecting an invention which are created by the grant of a patent. Also discusses changes made in the patent laws of the United States, with general discussion by members. 5800 w. Jour Assn of Engng Soc's—Dec., 1898. No. 25575 C.

LABOR.

Address.

Labor from a Technical and Economic View. (Technische und Wirtschaftliche Arbeit.) An address by Prof. Dr. Ehrenberg discussing the relation of applied technology to the practical industrial and commercial problems of the day. 7500 w. Zeitschr d Ver Deutscher Ing—Dec. 17, 1898. No. 25462 D.

Disputes.

The Effect of Labor Disputes on Foreign Trade. Mr. Ritchie's talk to a committee from the Trade Union Congress, on the desirability of an industrial peace, and the loss to labor and capital because of strikes in England. 1400 w. Col Guard—Dec. 23, 1898. No. 25059 A.

Primitive Industry.

Sex in Primitive Industry. W. J. Thomas. A study of the division of labor. 5000 w. Am Jour of Soc—Jan., 1899. No. 25247 D.

Unions.

Trade Unions and Public Duty. Jane Addams. A comparison of trades union and national measures, with defense of the methods employed by unions, and condemnation of the general public in its attitude toward industry. 6500 w. Am Jour of Soc—Jan., 1899. No. 25246 D.

Wages.

Some Valuable Wage Statistics. Considers statistics given in the Sept. number of the Bulletin of the U. S. Dept. of Labor. 2000 w. Gunton's Mag—Jan., 1899. No. 25070 C.

Working Hours.

Working Hours in French Industrial Establishments. (La Durée du Travail dans les Etablissements Industriels.) Résumé of the report of a commission appointed to supervise the application of the French factory law of 1897, with statistical data. 1200 w. Moniteur Industriel—Jan. 7, 1899. No. 25425 E.

MISCELLANY.

Beet Cultivation.

Beet Cultivation in Italy. Reports tabulated results of experiments carried out in Italy. 600 w. U. S. Cons Repts, No. 316—Jan. 5, 1899. No. 25013 D.

Brickmaking.

Brickmaking in England—The Accrington Shale District. John A. Turner. Historical and descriptive account with illustrations of machinery employed and of the works. 4000 w. Brick—Jan., 1899. No. 25250.

Cuba.

Cuban Reconstruction. Richard J. Hinton. Discusses the resources and industries of this island, the wrongs that have caused such disaster, the difficulties in the situation, &c. 4500 w. N Am Rev—Jan., 1899. No. 24979 D.

Personal Observations in Cuba During the War. J. W. Hopley. An account of the clay industry in the island with illustrations of Cuban scenes. 2800 w. Brick—Jan., 1899. No. 25248.

Hawaiian Islands.

Agriculture in the Hawaiian Islands. Dr. Harvey W. Wiley. Information concerning the character and formation of the soils, their fertility, the rainfall, crops and the conditions attending the practice of agriculture. 7500 w. Jour Fr Inst—Jan., 1899. No. 25127 D.

Paris Exposition.

The Approaches and Transportation Facilities of the Paris Exposition of 1900. E. L. Corthell. Information collected during a recent visit, including illustrated descriptions of the engineering works connected with the subject. 7500 w. Pro of Am Soc of Civil Engs —Jan., 1899. No. 25573 F.

The United States at the Paris Exposition in 1900. Ferdinand W. Peck. The importance to American trade of a fine exhibit and the value of this opportunity. 3500 w. N Am Rev—Jan., 1899. No. 24977 D.

The Paris Exposition of 1900. Francis S. Drake. Plan and illustrations with description, and general conditions and special features. 5000 w. St Ry Jour—Jan., 1899. No. 25037 D.

Prizes.

The Public Session of the French Academy of Sciences. (Séance Publique de l'Académie des Sciences.) The annual volume published by the Academy, containing the minutes of the public meeting, the award of prizes for the year past and notices of the prizes to be awarded next year. 60,000 w. Comptes Rendus—Dec. 19, 1898. No. 25419 D.

Report.

Annual Report of the President of the National Association of Manufacturers. Theodore C. Search. An interesting account of the year's work, discussing legislative measures, shipping, Nicaragua canal, Paris exposition, trade marks, international freght and transportation, &c. 12,500 w. Nat Assn of Mfrs, Form 316—Jan., 1899. No. 25373.

Review.

Commerce, Manufactures and Products. O. P. Austin. A review of the record made by the United States in the year 1898. 3000 w. Bankers' Mag, N. Y.—Jan., 1899. No. 25217 D.

Rubber.

Improvements in Vulcanization. (Modifications Apportées à la Vulcanisation au Soufre.) Report by Ach. Livache, upon a new process, due to MM. Bapst and Hamet. They use a bath of molten sulphur, kept hot by a steam jacket, so that the temperature is easily regulated and no inflammable vapors produced near a flame, as is the case when the bath is heated by a fire. Illustrated. 2000 w. Bulletin de la Société d'Encour—Dec., 1898. No. 25403 G.

Methods of Preparing Rubber. R. H Biffen. Considers some of the better-known varieties of rubber and the methods of preparation, and the need of research in this field. Reports the writer's recent success in preparing pure rubber by a physical process. 3000 w. Jour Soc of Arts —Dec. 23, 1898. No. 25095 A.

Technical Education.

Technical Education at the University of Wisconsin. Storm Bull. Reviews the history of technical education at this university. Ill. 4800 w. Wisconsin Engr—Jan., 1899. No. 25200 D.

The Education of Electrical Apprentices and Journeymen. Arthur A. Hamerschlag. Read at meeting of the Am. Inst. of Elec. Engs. Urging that the educating of apprentices and journeymen bears a vital relation to the future success or failure of the industry. 2800 w. Elec, N. Y.—Jan. 11, 1899. No. 25210.

The International Correspondence Schools, Scranton, Pa., with Special Reference to the Courses in Mining. H. H. Stork. An account of this undertaking and its marked success, with an outline of courses and methods. 4500 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24969 D.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Cables.

A Great Telegraph Scheme. Editorial discussion of the scheme to establish a complete system of cables around the globe, to be owned by the British government, maintaining that it would be best for the work to be carried out by private enterprise. 1500 w. Engr, Lond—Dec. 23, 1898. No. 25067 A.

Cables For Alternating Currents. (Wechselstrom-Kabelnetz.) H. Andriessen. A discussion of methods of increasing the capacity of cables, with especial reference to concentric cables. 1500 w. Elektrotech Zeitschr—Dec. 15, 1898. No. 25497 B.

Submarine Cable Laying. (La Pose des Cables Sous-Marins) L. Moreval. A well illustrated general description of methods employed. 5000 w. Le Génie Civil—Dec. 17 and 24, 1898. No. 25410 each D.

Duplex Telephony.

The Duplexing of Telephone Conductors.

(Doppelbenutzung von Fernsprech-Verbindungsleitungen.) A paper by Inspector Schwensky, discussing the various methods which have been used for sending telephone communications simultaneously over one wire, with especial reference to the method used by the German government. 7500 w. Elektrotech Zeitschr—Dec. 22, 1898. No. 25444 B.

"Independent" Telephony.

Some of the Latest Practice in "Independent" Telephony, at Battle Creek, Mich. Describes one of the latest, most convenient and economical systems in the independent field. Ill. 1000 w. Elec Eng, N. Y.—Jan 5, 1899. No. 25175.

Recorder Signal.

Siphon Recorder Signals. J. Rymer-Jones. Gives a series of illustrated experiments conveying information of value concerning the working of the Recorder under widely different conditions, on cables differing in length. 900 w. Elec Rev, Lond—Jan. 13, 1899. Serial. 1st part. No. 25511 A.

Space Telegraphy.

Coast-Telegraphs and Space-Telegraphy. Rollo Appleyard. The present limits of space telegraphy, the methods of coast telegraphs tried, and the success attained, with the methods now in favor. 4200 w. Nature—Jan. 12, 1899. No. 25507 A.

Hertz-Wave Telegraphy. (La Telegraphie Hertzienne sans Fil.) E. Ducretet. An illustrated historical and descriptive paper clearly presenting the status of present knowledge of the subject. 4500 w. Bulletin de la Société d'Encour—Dec., 1898. No. 25405 G.

Telegraphy by Magnetic Induction. S. Evershed. Read before the Inst. of Elec. Engs., England. The low-frequency electromagnetic system is presented; the method of forming the primary and secondary circuits, transmitting and receiving devices. 2700 w. Ind & Ir—Dec. 30, 1898. No. 25163 A.

Telegraphing Without Line Wires. William Bissing. Reviews the electrical development bearing on this form of signaling. Part first considers conduction, induction, and electromagnetic methods. 3000 w. Elec Wld—Jan. 14, 1899. Serial. 1st part. No. 25260.

The Zickler Electric Luminous Wireless Telegraph System. Describes a design differing essentially from proposed systems. It consists in utilizing ultra violet rays. Ill. 900 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25532.

Telegraphy.

Notes on Telegraphy and Telephony. W. H. Freedman. The present paper is devoted to telegraphy, giving its history, systems of codes, generators used, &c. 5800 w. Sch of Mines Qr—Nov., 1898. No. 25199 D.

Telephoning.

The Use of Telegraph Wires For Telephoning. (Auschaltung von Fernsprechsystemen an Morseleitungen.) O. Canter. Describes a method for the application of telephones to wires which are at the same time used for Morse telegraphing, in such a manner that neither interferes with the other even when used simultaneously. 1000 w. Elektrotech Zeitschr—Dec. 15, 1898. No. 25498 B.

DISTRIBUTION.

Mains.

Mains for Electricity Supply. F. J. Warden-Stevens. Considers the cables and the methods of laying them. 3300 w. Arch, Lond—Jan. 6 1899. Serial. 1st part. No. 25311 A.

Secondary Circuits.

Design of Secondary Circuits in Alternating Plants. George L. Thayer. Gives details of what is becoming standard practice, discussing improvements in the direction of better regulation and increased efficiency of distribution. 3800 w. Elec Wld—Jan. 28, 1899. No. 25594.

Switchboards.

Listening and Ringing Equipment for Switchboards. H. P. Clausen. Considers the various systems and devices in use. Ill. 2000 w. W Elect'n—Dec. 31, 1898. No. 24999.

Switzerland.

Electric Power in Switzerland. W. Cotgrave Betts. Some facts are given showing the rapid progress already made in the application of electric power to industrial purposes, but concluding that considering the natural conditions, electricity has not gained favor as rapidly as expected. 900 w. Power—Jan., 1899. No. 25092.

Utilization of the Rhine Water-Power in Switzerland. (L'Utilisation des Forces Motrices du Rhin en Suisse.) Illustrated account of the proposed exploitation of this power by the Swiss government. 2000 w. Le Génie Civil—Jan. 7, 1899. No. 25417 D.

Transformer Equipment.

The New Transformer Equipment of the Carborundum Company at Niagara Falls. J. S. Peck. Briefly describes the process of manufacture of carborundum, and the new transformer and regulator recently installed which doubles the capacity of the plant. Ill. 2500 w. Elec Wld—Jan. 7, 1899. No. 25168.

The Transforming Central Station of the Buffalo General Electric Company. Illustrates and describes this station, belonging to the Niagara system, and made necessary for adaptation of Niagara power for the various services. 3800 w. Elec Wld—Jan. 28, 1899. No. 25593.

ELECTRO-CHEMISTRY.

Accumulators.

Accumulator-Regulating Devices. Illustrates and describes the Heath and Field system. 900 w. Elec Eng, Lond—Jan. 13, 1899. No. 25515 A.

International Competitive Trials of Accumulators for Road Traction. Gives the programme of a competition that has been arranged for the trial of accumulators intended for automobile vehicles driven on ordinary roads. 2400 w. Elec Rev, Lond—Jan. 6, 1899. No. 25308 A.

Storage Batteries for Road Traction. Brief discussion of the batteries used in France for electric traction on common roads. 1100 w. Elec Rev, Lond—Dec. 23, 1898. No. 25052 A.

Aqueous Solutions.

Electrolytic Decomposition of Aqueous Solutions. L. Glaser. From the *Zeitschrift für Electrochemie*. Part first considers the formation of water in the gas battery (H O cell), and the decomposition of water. 1200 w. Elec Rev, Lond—Jan. 6, 1899. No. 25309 A.

Copper.

The Electrolytic Copper Industry. Gives details of production, conduct of the refining operations, &c. 1400 w. Engng—Dec. 30, 1898. No. 25155 A.

Electric Furnace.

See Heating and Welding.

Electromotive Force.

Changes of Electromotive Force Within the Secondary Cell. Charles Frederick Burgess. Deals with the means which are available for studying single potential differences which exist in different parts of the cell, and gives some of the data which was obtained in the application of one of these methods. 3700 w. Wisconsin Engr—Jan., 1899. No. 25202 D.

Mill Scale.

The Removal of Mill Scale and Magnetic Oxide by Electricity. Sherard Cowper-Coles. Describes processes that have been tried for the removal of mill scale from forgings and plates. 700 w. Engng—Dec. 30, 1898. No. 25156 A.

Photographic Action.

The Chemical Action of the Electric Current on Gelatino-Bromide Dry Plates. (Die Chemischer Wirkung des Elektrischen Stromes auf Bromsilber-Gelatin-Trockenplatten.) Emil Jahr. With reproductions of plates upon which the current has acted. Tests were made with currents of various tensions. 1200 w. 1 plate. Elektrochemische Zeitschr—Jan., 1899. No. 25450 H.

Review.

Applied Electro Chemistry: A Retrospect and a Prospect. E. Edser. Notes briefly applications successful and unsuccessful. 2200 w. Elec Eng, Lond—Jan. 6, 1899. No. 25324 A.

Electro-chemistry in the Year 1898. (Die Elektrochemie im Jahre 1898.) A general index of the important papers which have appeared in the technical journals of many countries upon electrochemistry and allied branches. 4000 w. Elektrochemische Zeitschr—Jan., 1899. No. 25451 H.

The Electro-Chemical and Electro-Metallurgical Industries in 1898. John B. C. Kershaw. Reports steady advance along the industries already in operation, but no new developments of importance. Deals with the more important industries seriatim. 2000 w. Elec Rev, Lond—Jan. 13, 1899. Serial. 1st part. No. 25513 A.

ELECTRO-PHYSICS.

Radiography.

A New Process of Printing by the Use of X-Rays. Typo-Radiography Faster Than Any Conceivable Method Now Used. Frederick Strange Kolle. An account of experiments in this field, with description of preparation of inks, and report of results obtained. 3500 w. Elec Eng, N. Y.—Jan. 19, 1899. No. 25339.

Izambard Process of Printing by X Rays. Brief account of experimenting with Röntgen rays in the hope of adapting them to commercial use in the printing industry. 1000 w. Elec Eng, N. Y.—Jan. 12, 1899. No. 25222.

Roentgen Rays. W. C. Roentgen. Reports some experiments. 1600 w. Sci Am Sup—Dec. 31, 1898. No. 24942.

Tempered Steels.

The Magnetic Properties of Tempered Steels. A condensed translation of an article by Mme. Sklodowska Curie, in the *Bulletin de la Société d'Encouragement pour l'Industrie*, giving an account of her numerous systematic experiments. Ill. 2000 w. Elec Rev, Lond—Jan. 13, 1899. Serial. 1st part. No. 25512 A.

GENERATING STATIONS.

Armatures.

Practical Balancing of Armatures. George T. Hanchett. An illustrated explanation of the writer's ideas on this subject. 1300 w. Elec Eng, N. Y.—Dec. 29, 1898. No. 24936.

Beauport, Canada.

Electrical Plant at the Beauport Insane Asylum. Illustrates and describes a complete plant of small size which furnishes light and power. 1000 w. Can Elec News—Jan., 1899. No. 25256.

Boston, Mass.

The Power Plant of the American Soda Fountain Company, Boston, Mass. H. W. Weller. A combination of electrical and mechanical transmission designed with careful attention to first cost and economy. Ill. 3500 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25530.

Brushes.

The Contact Resistance of Carbon and Copper Brushes. (Der Kontaktwiderstand von Kohlen und Kupferbürsten.) E. Arnold. A very complete account of comparative tests made upon brushes of various materials, with diagrams showing the resistance, wear temperature, and other data; the results being discussed mathematically. 3000 w. Elektrotech Zeitschr—Jan. 5, 1899. No. 25447 B.

Carlisle, England.

Carlisle Electricity Supply Station. Illustrated detailed description of a station designed by A. B. W. Kennedy. It is a three-wire system, with an earthed middle wire and 460 volts between the outers. Also editorial. 3000 w. Elect'n, Lond—Dec. 23, 1898. No. 25049 A.

Compounding.

The Automatic Compounding of Alternating Dynamos. Maurice Leblanc. Extracts from a paper recently presented before La Société Internationale des Electriciens, describing an ingenious system of compounding. Ill. 1400 w. Elec Wld—Jan. 14, 1899. No. 25261.

Dynamos.

The Magnetic Elements of Dynamo Construction. J. Warren. A study of the laws of magnetism in their bearing on dynamo design. 1100 w. Elec, Lond—Dec. 23 and 30, 1898. Serial. 2 parts. No. 25046 each A.

Field Windings of Dynamos. Arthur L. Rice. The use of field winding is explained and the considerations which determine the size of wire, and other important determinations. 2000 w. Am Elect'n—Jan., 1899. No. 25564.

Dublin.

The Power Station of the Dublin United Tramways Co., Limited, Dublin, Ireland. Illustrated detailed description of a station designed to furnish power for an extensive system. 900 w. Power—Jan., 1899. No. 25091.

Grenada.

Steam-Driven Electric Station at Grenada, Spain. (Usine Electrique à Vapeur de Grenade, Espagne.) R. B Ritter. Illustrated description of an interesting plant, using Niclausse boilers, simple engines and single phase high-tension alternators. 4000 w. 1 plate. Le Génie Civil—Dec. 24, 1898. No. 25413 D.

Jamaica, W. I.

An American Light and Power Plant, Montego Bay, Jamaica, West Indies. Illustrates and describes a plant started recently and running satisfactorily. 900 w. Elec Eng, N. Y.—Jan. 5, 1899. No. 25172.

Lighting Works.

Electric Lighting Works. Neville Appelbee. Some of the more important points in designing the mechanical portions of steam-driven electricity works, and the plant used in them. 2600 w. Prac Engr—Jan. 6, 1899. No. 25304 A.

Lyons.

The Utilization of the Power of the Rhone at Lyons. (Ausnützung des Wasserkraft des Rhôneflusses bei Lyon.) Anton Klir. An illustrated description of the canal de Jonage which cuts across a loop of the Rhone and enables 12,000 h. p. to be utilized at Lyons. 4000 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1899. No. 25488 D.

Niagara.

Lessons from the Niagara Power Plant. Reviews the statements of Dr. Coleman Sellers concerning the changes considered necessary by experience in operating the plant. 1200 w. Eng Rec—Jan. 14, 1899. No. 25240.

The Niagara Falls Power Plant. J. E. Woodbridge. The subject is treated from an engineering standpoint, giving reasons for adopting some of the features and details in the design, the additions just completed, and the conclusions which may be drawn. Fully illustrated. 9500 w. Elc Wld—Jan. 7, 1899. No. 25167.

The Power Plant of the Niagara Falls Hydraulic Power and Manufacturing Company. Illustrates and describes the plant, and the uses to which the power is applied. Also describes the Canadian Power Plant. 4500 w. Elec Wld—Jan. 14, 1899. No. 25259.

Paderno.

The Electric Station of Paderno on the Adda. (Das Elektricitätswerk in Paderno d'Adda.) E. Vannotti. An illustrated account of the hydraulic plant at Paderno, Italy; where 13,000 h. p. is developed and transmitted electrically over 19 miles. 3000 w. Elektrotech Zeitschr —Jan. 5, 1899. No. 25446 B.

Salisbury, England.

Salisbury Electric Light Station. Illustrates and describes this English station recently opened, with brief history of the buildings utilized. 2500 w. Elec Eng, Lond—Dec. 23, 1898. No. 25048 A.

Sparking.

The Limit of Sparking for Continuous Current Dynamos. (Die Funkengrenze bei Gleichstrommaschinen.) Gisbert Kapp. A mathematical derivation of a formula for the proportions which will prevent sparking in continuous current dynamos. 3000 w. Elektrotech Zeitschr —Jan. 5, 1899. No. 25448 B.

The Sparking of Continuous Current Dynamos. (Ueber die Funkenbildung an Gleichstrommaschinen.) J. Fischer-Hinnen. An elaborate mathematical analysis of the phenomena of sparking from a theoretical standpoint, deriving formulae adapted for practical use. Two articles. 10,000 w. Elektrotech Zeitschr—Dec. 22, 29, 1898. No. 25499 each B.

Storage Stations.

The Storage Battery Substations of the Metropolitan Street Railway, New York City. Describes the station at the foot of West 23d St., noting the peculiarities. 1900 w. Elec Wld—Jan. 21, 1899. No. 25332.

Switchboards.

The Electric Light and Power Switchboard. S. H. Sharpstein. Presents points of importance in relation to switchboard construction. 2000 w. Am Elect'n—Jan., 1899. No. 25569.

Transformers.

The Design of Transformers. Frederick W. Carter. On the best proportions to give to transformer cores, and the most advantageous distribution of the wasted energy, together with a direct method for the design of transformers, in order to obtain maximum all-day efficiency. Discussion. 9000 w. Trans of Am Inst of Elec Engs—Nov., 1898. No. 25522 D.

Washington, D. C.

Power House of the Capital Traction Company. Illustrated description of a 2000 k w station for a conduit electric road. 1500 w. Eng Rec—Dec. 31, 1898. No. 24989.

The New Power Station of the Capital Traction Co., Washington, D. C. Illustrated detailed description of the station and its equipment. 3700 w. St Ry Jour—Jan., 1899. No. 25032 D.

The Power Station of the Capital Traction Co., Washington, D. C. Describes and illustrates this new electric station, giving two-page plate. 2500 w. Eng News—Jan. 26, 1899. No. 25544.

HEATING AND WELDING.

Electric Furnace.

The Electric Furnace. F. Jarvis Patten. Illustrates and describes different furnace systems, giving briefly the history of researches in this field. 3300 w. Am Elect'n—Jan.,1899. No. 25562.

The Principal Electric Furnaces of 1897. (I Principali Forni Elettrici del 1897.) L. Belloc. A collection of illustrated descriptions of all the types of electric furnaces brought out in that year. 6000 w. L'Elettricita--Dec., 1898. No. 25421 E.

Transformers.

A Design for a Small Welding Transformer. George T. Hanchett. An illustrated description of a simple device of this class, which can be made from cheap materials with simple tools. 2000 w. Am Mach—Jan. 26, 1899. No. 25-539.

LIGHTING.

Arcs.

Arcs and Non-Arcing Metals. George T. Hanchett. States phenomena observed and presents conclusions drawn, methods of avoiding arcs, &c. 1700 w. Am Elect'n—Jan., 1899. No. 25566.

Isolated Plant.

I. Some Practical Hints on the Production and Use of Electricity for Lighting Country Houses. Bernard M. Drake. II. Practical Applications of Electric Power. H. R. J. Burstall. The first paper considers the different methods, treatment of rooms, &c. The second paper discusses the general principles and the question of cost, describing typical forms of apparatus. Both papers are illustrated, and are discussed together. 10,500 w. Jour Roy Inst of Brit Archts—Dec. 24. 1898. No. 25506 B.

Lamp Factory.

A Modern Arc-Lamp Factory. Illustrated description of the plant of the Standard Thermometer and Electric Co. at Peabody, Mass. 1500 w. Elec Rev, N. Y.—Jan. 4, 1899. No. 25018.

Light and Power Co.

The History and Growth of the People's Light and Power Company of New Jersey. Max Loewenthal. Full illustrated account of the organization and expansion of this company. 6300 w. Elec Eng, N. Y.—Jan. 5. 1899. No. 25171.

Lighting Works.

See Generating Stations.

Small Plants.

Why Some Small Electric Light Plants Do Not Pay. J. R. Cravath. Discusses the engineering and business management, noting the mistakes often made. 2300 w. Elec Eng, N. Y.—Jan. 12, 1899. No. 25221.

MEASUREMENT.

Bridge.

Modified Bridge Method of Measuring Resistances Containing Earth Currents. R. R. Black. Describes a method of measuring the resistance of a cable by reversals when earth currents are strong and variable. 450 w. Elect'n, Lond—Jan. 13, 1899. No. 25516 A.

Counter.

Scribner's Connection-Counting Mechanism for Telephone Lines. Illustrated description. 800 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25531.

Hysteresis Meter.

The Blondel-Carpentier Hysteresis Meter. (L'Hysteresimetre Blondel-Carpentier.) A. Blondel. Illustrated description of an ingenious instrument for measuring hysteresis in a sample of metal. 1200 w. L'Electricien—Jan. 7, 1896. No. 25423 B.

Leakage.

A Direct Reading System for Measuring Current Leakage. Dr. M. Kallmann. Abstract of a paper read before the Verband Deutscher Elektrotechniker. Describes the system and enumerates its most important applications. 2200 w. Elect'n, Lond—Dec. 23, 1898. No. 25050 A.

Meters.

General Meter Practice. Lyman C. Reed. Deals with the practical arrangement of a modern meter department. Ill. 1700 w. Am Elect'n —Jan., 1899. No. 25570.

New Multiple Electric Hour-Meter. (Nouveau Compteur Electrique Horaire Multiple.) M. Aliamet. Illustrated description of the Cauderay meter, which is a clock meter with multiple circuits and a totalizing device. 2000 w. L'Electricien—Dec. 17, 1898. No. 25422 B.

Systems of Meter Rates. Edwin L. Debell. Read before the Northwestern Elec. Assn. Aims to show how the conditions of the electrical industry are affected by the system of rates employed, and considers what system will be just to customers and also improve the earnings. 3500 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25535.

The Practical Testing of Electricity Meters for Central Stations. C. A. L. Prusmann. Deals somewhat exhaustively with the process and methods of testing electricity meters. Considers the equipment of the meter-room, different types of modern meters, and testing. 2700 w. Elec Eng, Lond—Jan. 13, 1899. Serial. 1st part. No. 25514 A.

Voltameter.

A New Quicksilver Voltameter. (Ueber ein Neues Quecksilber-Voltameter.) Dr. L. Gurwitsch. The determination is effected by measuring the influence of the current on the volume of mercury flowing through a capillary aperture. 1500. Zeitschr f Elektrochemie—Jan. 5, 1899. No. 25449 H.

POWER APPLICATIONS.

Electric Launch.

A Design for an Electric Launch Motor. Charles T. Child. Illustrated description of a motor of simple construction which can be built at small cost. It is of a four-pole inclosed type, waterproof and intended to be attached directly to the screw shaft. 4500 w. Sci Am Sup—Jan. 14, 1899. No. 25192.

Electric Lifts.

Electric Lifts for the New Brighton Eiffel Tower. Illustrates and describes an extensive system of lifts to be used in the highest tower yet built, to be constructed at a popular resort on the river Mersey. 1200 w. Engr, Lond—Jan. 6, 1899. No. 25271 A.

Electric Pumping.

See Mining and Metallurgy, Mining.

Motors.

Alternating Current Synchronous and Induction Motors. Ernst Julius Berg. On the construction and use of these motors, dealing in this part mostly with synchronous motors. 1500 w. Am Elect'n—Jan., 1899. No. 25567.

Mine Plant.

The Electric Plant of the Silesian Coal Mines at Gottesburg. (Die Elektrischen Anlagen der Schlesischen Kohlen- und Kokswerke zu Gottesburg.) Max Schmidt. An illustrated account of this extensive plant for underground lighting and pumping in the Silesian coal mines. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 24, 1898. No. 25463 D.

Power for Mills.

Power for Woolen Mills. C. J. H. Woodbury. Read at meeting of the Nat. Assn. of Wool Mfrs. Presents the advantages of electric transmission. 2500 w. Bos Jour of Com—Jan. 14, 1899. No. 25223.

Power Subdivision.

Domiciliary Electric Power Distribution in the St. Etienne Region. (Le Transport Electrique de la Force Motrice à Domicile dans la Région de St. Etienne.) Edouard Simon. A very complete description of the distribution of electric power among the ribbon weavers of the St. Etienne (France) district. There are 30,000 ribbon-looms, not grouped in factories, but mostly by twos and threes in the houses of workmen or small dealers. The distribution occupies 110 kilometres of lines, worked at 5,200 volts, three-phase. About 2,500 looms, each absorbing about ¼ h. p. are connected, and 8,000 incandescent lamps. The paper minutely describes the contract method of charging for power used by this installation. Ill. 3500 w. Bulletin de la Société d'Encour—Dec., 1898. No. 25404 G.

Power Tests.

See Mechanical Engineering, Power and Transmission.

Speed Regulation.

Speed Regulation of Electric Motors. Allan D. Adams. Considers speed changes that originate in the motor. 900 w. Am Mach—Jan. 26, 1899. No. 25541.

Stage Mechanism.

Electrical Stage Mechanism at Drury Lane Theatre. Illustrates and describes some of the arrangements for remodelling this stage, especially describing two sections of the stage floor worked by electric power. 2000 w. Engng—Dec. 23, 1898. No. 25062 A.

TRANSMISSION.

Copper Economy.

Economy of Copper in Transmission Lines. Budd Frankenfield. Assistance in determining the choice of a particular system of distribution, copper economy being the criterion of judgment. 1600 w. Wisconsin Engr—Jan., 1899. No. 25205 D.

Niagara-Buffalo.

The Use of Niagara Power by the Buffalo General Electric Company. Orrin E. Dunlap. Illustrated description of the new plant, its novel features of construction and apparatus. This is the most important application of electric power after a long transmission extant. 3000 w. Elec Eng, N. Y.—Jan. 5, 1899. No. 25173.

Three-Wire.

Conductors for the Three-Wire System. William Herbert Donner. Explains the saving of wire in the use of the three-wire over the two-wire system. 1100 w. Am Elect'n—Jan., 1899. No. 25568.

MISCELLANY.

Accounting.

Methods of Charging for Electricity in America. R. S. Hale and J. S. Codman. A brief account of the various methods in use in the United States for metering, discounts, contracts, etc. 1400 w. Elec Rev, Lond—Jan. 6, 1899. No. 25310 A.

Rate Schedules and Dividends. A consideration of the rate schedules of medium-sized plants and suggestions for more equitable methods. 2200 w. Can Elec News—Jan., 1899. No. 25257.

Electricians.

The Electrical Engineer. Editorial comment on a remark made in Mr. Preece's inaugural address, and prophesying that electrical engineers are destined to become known merely as engineers, a knowledge of electricity being understood to be a part of the necessary equipment of all bearing the name. A sensible and timely argument. 1500 w. Engng—Dec. 23, 1898. No 25150 A.

Legislation.

Recent Legistation in Relation to the Supply of Electricity for Light and Power. Frank Balfour Browne. A discussion of the effect of legislation on the development of the industry. 1800 w. Elec Rev, Lond—Jan. 6, 1899. No. 25307 A.

Review.

Electrical Engineering in 1898. A view of the year's progress in all the branches of electrical work, forming a portion of a general review of the engineering progress of the year. 4300 w. Engr, Lond—Jan. 6, 1899. No. 25272 A.

Shanghai.

Telephone and Tramway Systems in Shanghai. A statement of the conditions existing and the necessity of exercising care in bidding for tramway or other franchises. 1000 w. U. S. Cons Repts, No. 323—Jan. 13, 1899. No. 25225 D.

MARINE ENGINEERING.

Counterbalancing.

Studies upon Counterbalancing Marine Engines. (Alcuni Studi sul Bilanciamento delle Macchine a Vapore Marine.) A. Perroni. An elaborate mathematical paper, illustrated with diagrams. 11,000 w. Rivista Marittima—Dec., 1898. No. 25430 H.

Electric Launch.

See Electrical Engineering, Power Applications.

Ferry Boats.

The History of Ferry Boats. (Le Bac à Travers les Ages.) Daniel Bellet. Illustrated popular article. 1200 w. La Nature—Dec. 17, 1898. No. 25401 B.

The New Double-Screw Ferry Steamer "Berkley," of the Southern Pacific Co. Illustrated description of a large ferry steamer just put in service on the San Francisco Bay ferry-line, between the foot of Market St., San Francisco, Cal., and Oakland Pier. 500 w. Eng News—Dec. 29, 1898. No. 25946.

Ice-Breaking.

New Ice-Breaking Steamer for Russia. From the *Newcastle Daily Chronicle*. Describes the launch of an ice-breaking vessel, larger, heavier and more powerful than any yet built. Gives particulars and dimensions. 900 w. U. S. Cons Repts, Vol. LIX—Jan., 1899. No. 25026 D.

Keels.

Cambered Keels. States the leading particulars of the case of Burrell v. Russell, which has excited much interest in England, and calls attention to erroneous views entertained in regard to the influence of cargoes upon a vessel's form. 2200 w. Engr, Lond—Jan. 13, 1899. No. 25390 A.

Launch.

Launch of the Oceanic. Full details of this vessel and the novel method of launching. Ill. 2500 w. Marine Rev—Jan. 19, 1899. No. 25362.

Management.

The Management of an Ocean Steamship Line. Franklin Matthews. A review of the work of various departments, showing the great executive ability required, the responsibility of those in charge, and many details of the work. 2800 w. Harper's Wk—Jan. 7, 1899. No. 25010.

Merchant Marine.

Merchant Marine of France. Points of interest upon the present condition. 1600 w. U. S. Cons Repts, No. 320—Jan. 10, 1899. No. 25145 D.

Our Foreign Merchant Marine. Frank J. Firth. Argument on the subject of United States shipping. 1200 w. Marine Rev—Jan. 12, 1899. No. 25227.

The Condition of the Italian Mercantile Marine. (Le Condizioni della Marina Mercantile Italiana.) Antonio Teso. An interesting statistical review of the status of Italian shipping, with many tables and data. 9000 w. Rivista Marittima—Dec., 1898. No. 25429 H.

Ocean Steamers.

The Manœuvring Power of Ocean Steamers. Information given by commanders of various vessels in reply to stated questions. 1700 w. Naut Gaz—Jan. 26, 1899. No. 25043.

Propellers.

The Basis of Propeller Design. J. Denholm Young. Read at meeting of the Liverpool Engng. Soc. Discusses the things that effect the performance of propellers. 2500 w. Steamship—Jan., 1899. No. 25138 A.

Propulsion.

Modern Steamship Propulsion. W. H. Atherton and A. L. Mellanby. Part first discusses the resistance and power of steamships. 2300 w. Prac Engr—Jan. 13, 1899. Serial. 1st part. No. 25508 A.

Slip and Its Relation to the Problem of Screw Propulsion. Edmund Leavenworth. Part first explains what slip is and the causes of variability. 2200 w. Marine Engng—Jan., 1899. Serial. 1st part. No. 25133 C.

Review of 1898.

Marine Engineering and Shipbuilding in the Year 1898 in the United Kingdom. A review of work in the different districts. 11,500 w. Engr's Gaz—Jan., 1899. No. 25139 A.

Shipbuilding.

A Problem in Shipbuilding. *From Illustrirte Zeitung*. Illustrations and brief description of the details of the work in lengthening the North German Lloyd Steamer "Spree," and transforming it from a single to a twin screw steamer. 1200 w. Sci Am Sup—Jan. 7, 1899. No. 25039.

New Vessels Being Constructed in United States Ship-Yards. A list with particulars of the vessels now under construction in the United States ship-yards, including both merchant and government work. 2400 w. Naut Gaz—Jan. 12, 1899. Serial. 1st part. No. 25209.

Shipbuilding in America. Editorial discussion of the competition that is inevitable in this industry and the prospects of success for the United States. 2200 w. Engng—Dec. 30, 1898. No 25154 A.

Thames Shipbuilding and Marine Engineering. A summary of the work, with tabular statement of the principal ships built by each firm. 3800 w. Engr, Lond—Dec. 30, 1898. No. 25157 A.

Signalling.

Signalling at Sea. (Le Segnalazioni in Mare.) Giuseppe Gavotti. An interesting article by a Vice Admiral of the Italian Navy, tracing the history of sea signalling from ancient times to the present. 9000 w. Rivista Marittima—Dec., 1898. No. 25428 H.

Steamboats.

Fast Side-Wheel Steamer. Illustrated description of the "Toronto," built at the Bertram Engine Works, for Richelieu & Ontario Navigation Co., for lake service. 1200 w. Marine

Rev—Jan. 12, 1899. No. 25226.

Robert Fulton and the Steamboat. Robert H. Thurston. On the amount of credit due to Fulton for the invention, and the claims of others. 1500 w. Sci Am—Jan. 21, 1899. No. 25342.

The Belgian Steamers of the Ostend-Dover Line. (Les Paquebots Belges de la Ligne Ostende-Douvres.) Daniel Bellet. A well-illustrated description of these fine boats. They have paddle-wheels, inclined compound engines, and make 22 knots. 6000 w. La Revue Technique—Dec. 25, 1898. No. 25408 D.

Steamships.

The Oceanic. Particulars concerning this vessel. It is the largest vessel yet built but does not aim to be the fastest, planning rather for uniformity in passage. 2000 w. Engr, Lond—Jan. 6, 1899. No. 25269 A.

The Union S.S. Co.'s New Steamer "German." Illustrated description of the latest vessel added to the line between England and Africa. 800 w. Steamship—Jan., 1899. No. 25137 A.

The White Star Liner "Oceanic." Editorial describing this largest vessel ever launched, and giving comparison with other notable vessels. 5500 w. Engng—Jan. 13, 1899. No. 25384 A.

Steering Gear.

The Harfield Steering Gear of the Italian Cruiser Carlo Alberto. (Meccanismo Harfield per il Timone della R. Nave Carlo Alberto.) An illustrated description of a steam steering gear of English origin, especially suited for naval vessels. 1800 w. 2 plates. Rivisita Marittima—Dec., 1898. No. 25431 H.

Submarine Boat.

Lake Submarine Boat "Argonaut." Illustrated detailed description of this vessel 1600 w. Elec Eng, N. Y.—Dec. 29, 1898. No. 24938.

I. Voyaging Under the Sea. Simon Lake. Illustrated account of the submarine boat "Argonaut" and her achievements. II. A Voyage on the Bottom of the Sea. Ray Stannard Baker. An illustrated account of an excursion in the "Argonaut." 7500 w. McClure's Mag—Jan., 1899. No. 24933.

Surveying.

Submarine Survey. Charles Bright. Part first considers the methods and appliances used in this work. Ill. 3000 w. Engng—Jan. 13, 1899. Serial. 1st part. No. 25380 A.

Water Tubes.

Fragmentary Remarks on the Water-Tube Boiler in Marine Work. William Burlingham. Discusses various types used in different countries, the sources of trouble, the reasons for their use, &c., &c. Ill. 300 w. Marine Engng—Jan., 1899. No. 25132 C.

MECHANICAL ENGINEERING.

AUTOMOBILISM.

Accumulator.

The Box and the Accumulator. (Le Coffret et l'Accumulateur.) H. Jarry. A discussion of the advantages of standardizing the batteries of electric automobiles and the cases containing them so that they would be interchangeable. 1300 w. Revue des Transports Parisiens—Dec. 1, 1898. No. 25425 D.

Electric Vehicles.

Electric Vehicles and Their Relations to Central Stations. Percy Maxim. Abstract of paper read before the Northwestern Elec. Assn. Considers the applications of these vehicles to practical purposes and the advisability of stations providing their plants with the apparatus necessary to charge them. 3300 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25536.

The Milde Electric Voiturette. A brief illustrated description of a novel automobile. 300 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25534.

Exposition.

The Exposition of Automobiles at the Tuileries, Paris. (L'Exposition des Automobiles des Tuileries.) M. Barbet. A description of the vehicles exhibited, with 57 illustrations. 7000 w. Rev de Mecanique—Dec., 1898. No. 25426 H.

Gearing.

A Hydraulic Variable Speed Gearing. An illustrated description of a patent of Mr. Hall and the important points secured. 1300 w. Engr, Lond—Jan. 19, 1899. No. 25394 A.

HYDRAULIC ENGINEERING.

Contractor's Plant.

A Hydraulic Sand Plant. Illustrates and describes a method of dredging, transporting and washing sand by water. 1000 w. Eng Rec—Jan. 21, 1899. No. 25354.

Fluid Motion.

Further Experiments on the Character of Fluid Motion. H. S. Hele-Shaw. Read before the Liverpool Engineering Soc. Illustrated description of recent results of experimental study. 9000 w. Engng—Jan. 6, 1899. No. 25286 A.

Pump Action.

Suction or Pressure? Considers the principle which underlies the mode of action of pumps, siphons, barometers, &c. 2000 w. Mines & Min—Jan., 1899. No. 25114 C.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

Ball Bearings. C. R. Gerrard. A discussion of some of the important features of anti-friction bearings as they stand at present. Ill. 2500 w. Mech Engr—Dec. 24, 1898. No. 25219 A.

End-Trust Ball Bearings. Thomas Hill. A report of investigations and conclusions. Ill.

800 w. Am Mach—Jan. 5, 1899. No. 25083.

Fundamental Facts Relating to Ball Bearings. Reynold Janney. Illustrated discussion of fundamental principles. 2000 w. Am Mach—Jan. 5, 1899. No. 25084.

Boring Machine.

Double Boring and Milling Machine. (Doppelte Bohr-und Fräsmachine.) An illustrated description of a large boring machine, designed by the Oerlikon Machine Works, and especially adapted for electrical work. Zeitschr d Ver Deutscher Ing—Jan. 7, 1899. No. 25472 D.

Brass Bushes.

Fitting Brass Bushes. F. H. Directions for the turning and insertion of bushes, and the care necessary with the larger sizes. Ill. 1500 w. Mech Wld—Dec. 23, 1898. No. 25045 A.

Caliper.

A New Form of Contour Caliper. W. F. Durand. An instrument devised to determine whether or not the contour or cross section of a pin, axle or spindle is circular, and if not the finding where it departs from the true or circular outline. Illustrated description. 1700 w. Sib Jour of Engng—Jan., 1899. No. 25396 C.

Center Plates.

A Study in Center Plates. George L. Fowler. Discusses design and choice of material, and recommends a form of plate that may be adopted as a standard. Ill. 3300 w. R R Car Jour—Jan., 1899. No. 25229.

Dies.

Die Construction. George B. Painter. An explanation of methods and rules to be observed. Ill. 2200 w. Am Mach—Jan. 5, 1899. No. 25082.

Foundry Iron.

The Purchase of Foundry Iron on Analysis and a Standard System of Grading Pig Iron. A circular letter was sent out with the view of ascertaining the sentiment of foundrymen, and the first twenty replies are given in part first. 2300 w. Am Mfr & Ir Wld—Jan. 13, 1899. No. 20245.

Gears.

A Gear Trimmer. A. H. Cleaves. Illustrates and describes a device used in retouching small brass gears, which the writer believes would be very useful in similar work. 700 w. Mach, N. Y.—Jan., 1899. No. 25595.

Grinding.

Bicycle Cup and Cone Grinding Machines. Illustrates and describes some novel machines recently developed by the Pratt & Whitney Co., of Hartford, Conn. 1600 w. Am Mach—Jan. 12, 1899. No. 25181.

Gun Boring.

Boring a Thirteen-Inch Naval Gun. E. J. Prindle. Illustrates and describes the boring of this tube of a thirteen-inch breech-loading rifle at the Naval Gun Factory at Washington, D. C. 1000 w. Am Mach—Jan. 26, 1899. No. 25537.

Machine Tools.

A New Method of Boring, Milling, and Tapping Machine Frames by Use of Templates. E. Capitaine. From the *Zeitschrift des Vereines Deutscher Ingenieure.* Illustrates and describes a special portable tool. 2000 w. Ir Age—Jan. 26, 1899. No. 25525.

English and American Machine Tools. Extracts from a discussion in the London *Engineer* as to the relative merits of British and American tools. 5500 w. Ir Age—Jan. 26, 1899. No. 25526.

Machinists' Hardware.

See Economics and Industry, Commerce and Trade.

Melting Iron.

Experiments in Melting Iron. Edward Kirk. From advance sheets of a work on "Cupola Practice" soon to be issued. Further experiments are described and results given. 2500 w. Ir Trd Rev—Jan. 19, 1899. No. 25398.

Molding.

Molding a 30-Inch Check Valve in Loam. Arch. Landon. Illustrates and describes the method employed in the molding. 800 w. Foundry—Jan., 1899. No. 25320.

Molds. Warren E. Willis. Practical points of interest about molding, including casting, drop forging, coining, compressing, embossing, &c. 2500 w. Mach, N. Y.—Jan., 1899. Serial. 1st part. No. 25596.

Patching.

Mending Holes in Retorts. R. D. Moore. Describes manner of patching castings by "melting on." 900 w. Foundry—Jan., 1899. No. 25321.

Planer.

Machine For Planing Armor Plates. (Hobelmaschine zur Bearbeitung von Panzerplatten.) L. M. Schechter. A brief description of powerful planing machine constructed by the Charkow Machine Works, Russia, for use in the Russia naval workshops at Kolpina, near St. Petersburg, with plate of working drawings. 800 w. 1 plate. Zeitschr d Ver Deutcher Ing—Dec. 31, 1898. No. 25465 D.

Ratchet Drill.

The Making of a Ball-Bearing Ratchet Bit Brace. Illustrates and describes the methods connected with the manufacture of this brace as carried out at Plantsville, Conn. 2400 w. Ir Age—Jan. 5, 1899. No. 25014.

Shop Practices.

Electrical and Repair Shop Practices in Philadelphia. Illustrated description of the rearranged cables since the consolidation of the different companies, resulting in economy of current and copper, and facilitating examination. Also describes other improvements. 1000 w. St Ry Jour—Jan., 1899. No. 25304 D.

Special Work.

Special Operations in Large Electrical Works. Illustrates and describes some methods followed at the works of the Westinghouse Electric & Manufacturing Co. 1400 w. Am Mach—Jan. 19, 1899. No. 25337.

Tanks.

Cast-Iron Tanks. P. Hutchison. Information aiming to enable any draughtsman to design a cast-iron tank without having any previous knowledge of the subject. Ill. 700 w. Prac Engr—Dec. 30, 1898. No. 25148 A.

Tools.

Compressed Air Hose Tools. B. G. Miller. Illustrations and description of machines especially useful in doing the work on air hose and the pipes connected with the air-brake system. They are in use at the Fort Madison shops of the A., T. & St. F. Ry. 900 w. R R Car Jour —Jan , 1899. No. 25230.

Tool Works.

Herbert's Machine-Tool Works. Describes and illustrates these well-planned works, designed for the production of machine tools. 2800 w. Engng—Dec. 30, 1898. No. 25151 A.

Tubes.

The Production of Metallic Tubes by Extrusion. Illustrates and describes the system invented by Alexander Dick. 1800 w. Engng —Jan. 6, 1899. No. 25283 A.

Type Dovetailing.

A Type Dovetailing Job. Walter Gribben. Describes the inserting of some printers' type in the periphery of a tool steel wheel. Ill. 1400 w. Am Mach—Jan. 26, 1899. No. 25540.

Wood Working Machinery.

The Development of Wood-Working Machinery. John Richards. The first article of a series which will describe the growth of the now-working industry, the evolution of its machinery, and the present condition of the art. This installment is devoted to the general subjects of cutters and blades, and the development of the planer. Illustrated. 5600 w. Engineering Magazine—Feb., 1899. No. 25435 B.

Workmanship.

Good Workmanship. Editorial on the waste of time and labor in giving high finish when it adds neither to beauty or efficiency, considering it immoral. 1600 w. Engng—Jan. 6, 1899. No. 25284 A.

Works Management.

Machine-Shop Management in Europe and America. H. F. L. Orcutt. This paper, the second of a series, treats of labor-saving machinery, as exemplified in American works, and low-wage workmen, and contrasts the output and earning power of works equipped with high-class machinery and few men with those using many inferior men and poor tools. 3800 w. Engineering Magazine—Feb., 1899. No. 25433 B.

The Depreciation of Plant and its Relation to General Expense. H. M. Norris. A consideration of the practice of a number of metal working establishments in cost keeping, with reference to charges for depreciation of machines. 4300 w Engineering Magazine—Feb., 1899. No. 25441 B.

MATERIALS OF CONSTRUCTION.

Specifications.

The Coolgardie Steel Pipe Contract. A copy of the specifications and comment on the many-sided contract. 2000 w. Ir & Coal Trds Rev —Jan. 13, 1899. No. 25377 A.

Testing.

Prof. Martens on Testing Cast Iron. Dr. R. Moldenke. Presents the views of Prof. Martens with comments. 2500 w. Ir Trd Rev—Jan. 19, 1899. No. 25397.

Test Samples.

Standardizing Methods of Testing Metals. (Uniformisation des Méthodes d'Essais des Métaux.) Short abstract of a paper read before the Société Industrielle de l'Est by M. Baclé. An argument for interational standards in sizes and proportions of test pieces and methods of testing. 1000 w. Le Génie Civil—Dec. 17, 1898. No. 25412 D.

POWER AND TRANSMISSION.

Air Compression.

The Two-Pipe System of Air Compression. A. E. Chodzko. Considers the advantages claimed for it over the single-pipe system. 4400 w. Mod Mach—Jan., 1899. No. 25170.

Belting.

The Horse-Power of Belting. Rules for computing the horse-power which can be safely transmitted by a given belt, &c. 1000 w. Power —Jan., 1899. No. 25093.

Cable Hoist.

The St. Paul Cable Hoist. Illustrates and describes the conveyor plant recently built for the U. S. government at St. Paul, Minn. It solves the problem of dispensing with fall-rope carriers, which have heretofore been necessary for supporting the hoisting rope. 1000 w. Stone—Dec., 1898. No. 24935 C.

Coal-Handling.

Coal-Handling Machinery. Charles Piez. A discussion of continuous coal-handling machinery, under the two heads of elevators and conveyors. Ill. 4200 w. Pro of Engs' Club of Phila—Jan., 1899. No. 25176 D.

Coal Hoists.

The Coal Hoists of the Calumet and Hecla Mining Company. Julius Kahn. An illustrated description of the plant erected by this company at Lake Linden, Mich., and of its operation. 5500 w. Pro Am Soc of Civ Engs —Dec., 1898. No. 24934 F.

Compressors.

Automatic Air Compressors Adapted for Electric Motors. Illustrates and describes the Rix variable volume air compressor being installed at the North Star mine at Grass Valley, Cal. 1200 w. Min & Sci Pr—Dec. 31, 1898. No. 25079.

Cone Pulleys.

The Computation of Cone Pulleys for Machine Tools. (Zur Berechnung der Stufenscheiben für Werkzeugmaschinen.) Heinrich Weiss. An analytical and graphical discussion of the problem, resulting in general equations, and diagrams adapted for the proportioning of cone pulleys for lathes and similar machines. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 23, 1898. No. 25475 B.

Gears.

Table of Strength of Gears. John Fitch.

Gives a table for calculating the proper dimensions of gearing. 1000 w. Am Mach—Jan. 19, 1899. No. 25338.

Power Plants.

Finance and Economics of Power Plants. R. H. Thurston. A detailed study of this subject. 1800 w. Engr, U. S. A.—Jan. 1, 1899. Serial. 1st part. No. 25143.

Power Tests.

Power Tests of Motor Driven Machines. L. E. Lemon. Describes arrangements and methods of testing under various conditions. 2000 w. Mod Mach—Jan., 1899. No. 25169.

Shafting.

Diagrams for the Design of Shafts. G. Eugene Barrett. Diagrams with an explanation of their use. 600 w. Am Mach—Jan. 12, 1899. No. 25182.

SPECIAL MOTORS.

Diesel Motor.

Tests of a Diesel Motor. Condensed report by James E. Denton, of a series of economy tests, using various kinds of oil as fuel. Describes the motor and gives results. 2300 w. Eng News—Dec. 29, 1898. No. 24951.

Gasoline Motor.

A New Gasoline Motor. From *La Nature*. Illustrates a motor and carbureter and explains the process by which it manufactures its supply of gas for itself. 1200 w. Sci Am Sup—Jan. 14, 1899. No. 25193.

Oil Engines.

The Oil Engine for Motor Cars. Considers the oil engine as it is and as it ought to be, chiefly with view to its application to self-propelled vehicles, 2800 w. Engr, Lond—Jan. 6, 1899. Serial. 1st part. No. 25268 A.

Petroleum Motor.

Petroleum Power Engine. (Petroleum-Kraft-Machine.) E. Capitaine. Illustrating and describing Capitaine's improved petroleum motor, with very complete exhibition of details, showing much ingenuity of design. 4500 w. Zeitschr d Ver Deutscher Ing—Dec. 31, 1898. No. 25466 D.

Producer Gas.

Direct Utilization of Producer Gas in Europe. E. P. Buffet. Abstract of a review of the results as far as known that have been obtained in Europe with the use of producer gas in gas engines, as given by Aug. Dutreux, in *Le Génie Civil.* 2500 w. Am Mach—Jan. 26, 1899. No. 25538.

STEAM ENGINEERING.

Blowing Engines.

Compound Blowing Engines. Illustrates and describes a pair of vertical cross compound blowing engines. 1400 w. Engng—Jan. 6, 1899. No. 25282 A.

Boiler.

The Steam Boiler and Its Safety. F. G. Mitchell. Read before the Hamilton Assn., C. A. S. E. Calls attention to some points affecting the safety of boilers. 1000 w. Can Elec News—Jan., 1899. No. 25258.

Boiler Explosion.

A Noteworthy Boiler Explosion. Gives in full the report of the Board of Trade relating to the explosion of a boiler at St. George's, Bridge Street, Norwich, Eng. 5500 w. Engr, Lond—Dec. 23, 1898. No. 25068 A.

Boiler Explosion at Barking. An account of an extremely violent explosion, accompanied by loss of life. The first recorded instance of the accidental explosion of the shell of a "Scotch" boiler. Illustrations and editorial. 2800 w. Engr, Lond—Jan. 13, 1899. No. 25393 A.

Boiler Testing.

Notes on Testing Steam Boilers. Frederick Grover. The notes refer to such tests as are necessary to determine the economic performances. 2000 w. Mech Wld—Jan. 6, 1899. Serial. 1st part. No. 25299 A.

Counterbalancing.

See Marine Engineering.

Cylinder Ratios.

Cylinder Ratios for Compound Engines. George I. Rockwood. Read before the Providence Assn. of Mech. Engs. A discussion of the merits of large ratios. 6000 w. Eng Rec—Jan. 7, 1899. No. 25103.

The Computation of Triple Expansion Engines. (Die Berechnung und Dimensionirung der Dreifach-Expansionsmachinen.) J. Illeck. An elaborate application of the author's graphical method to the determination of cylinder ratios for triple expansion steam engines. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 16, 1898. No. 25473 B.

The Determination of Cylinder Sizes. J. C. Cornock. A study of the considerations affecting the sizes of cylinders, the effect of compounding, &c. 3000 w. Mech Engr—Dec. 24, 1898. No. 25220 A.

The Graphical Computation of Multiple Cylinder Engines. (Die Graphische Berechnung Mehrcylindriger Dampfmaschinen.) J. Illeck. Giving a graphical diagram from which the proper cylinder ratios may be determined for given conditions. 1500 w. Zeitschr d Ver Deutscher Ing—Jan. 7, 1899. No. 23471 D.

Economy.

Economy of Steam Production. A. L. Harrison. Considers the boiler and appurtenances, and boiler-room practice. 1700 w. Am Elect'n Jan., 1899. No. 25571.

Improvement in the Economy of the Steam Engine. W. F. Durand. A study of the thermal efficiency of the engine, and the various conditions upon which it depends. 1700 w. Am Elect'n—Jan., 1899. No. 25565.

Engine Test.

Test of an Allis Pumping Engine at St. Paul, Minn. Reports a 72-hour test of an engine at the McCarron Lake pumping station, and the satisfactory results. 800 w. Eng News—Dec. 29, 1898. No. 24950.

Feed Water.

Feed Water Filters. A. E. Shute. An illustrated description of such examples as seem most important and popular. 3600 w. Col Guard—Dec. 30, 1898. No. 25160 A.

Governors.

Steam Engine Governors. John Davidson. Read before the Salford Science Students' Assn. Part first discusses the throttle and variable expansion governors, quoting from various writers. 1800 w. Prac Engr—Jan. 6, 1899. Serial. 1st part. No. 25305 A.

High-Speed Engines.

High-Speed Engines. J. H. Dales. Read at meeting of British Inst. of Civ. Engs. Abstract of paper stating that the ordinary rates of rotation could with impunity be exceeded to the extent of 30 to 50 per cent. by the application of an adjustment of bearing brasses; also gives suggestions on good governing. 1300 w. Ir & Coal Trds Rev—Jan. 13, 1899. No. 25378 A.

Plugs.

Fusible Plugs. An explanation of their mechanism and why they burn out. 1000 w. Bos Jour of Com—Jan. 14, 1899. No. 25224.

Pumping.

An Engine Builder's View of Present Pumping Practice. Reviews a paper by Irving H. Reynolds, of the Edward P. Allis Co. 3000 w. Eng Rec—Jan. 21, 1899. No. 21357.

Test of a Steam Pumping Engine. Gives the results of a test of a 5,000,000-gal compound fly-wheel pump. 450 w. Eng Rec—Jan. 21, 1899. No. 25356.

See Municipal Engineering, Water Supply.

Reaction.

The Reactive Influence of Steam. W. J. M. Considers the reactive influence of a fluid, such as steam, in producing motion, when the steam flows into the atmosphere. 1000 w. Engr, Lond—Jan. 6, 1899. No. 25270 A.

Saturated Steam.

Concerning Regnault's Calorie and Our Knowledge of the Specific Volumes of Steam. G. P. Starkweather. Reviews experiments with superheated steam, noting discrepancies and concluding that knowledge concerning the density of steam is limited to the saturation line. 7200 w. Am Jour of Sci—Jan., 1899. No. 24976 D.

Scale.

The Effect of Scale on the Evaporation of a Locomotive Boiler. L. B. Breckenridge. Gives details of a series of tests recently completed at the Univ. of Illinois. 1400 w. R R Gaz—Jan. 27, 1899. No. 25555.

Smoke.

Competition for the Suppression of Smoke Produced by Boiler Furnaces in Paris. (Concours de la Ville de Paris pour la Suppression des Fumées Produites par les Foyers des Chaudières à Vapeur.) This most important review of the tests made by the city of Paris of various smoke-suppressing devices goes at great length into details of tests and conclusions reached. Fully illustrated. 38,000 w. Rev de Mecanique—April, June, Sept., and Dec., 1898. No. 25428, each H.

The Prevention of the Emission of Dense Smoke in Cities and in Other Places. Reviews methods devised for the prevention of smoke emission, and describes the "Lowe" smoke preventer, which is considered the most simple, least costly, and most efficient device yet invented. Ill. 8400 w. Ind & Ir—Dec. 23, 1898. No. 25055 A.

Steam.

Steam Consumption. Editorial comment on a paper by R. A. Ziese in *Zeitschrift des Vereins Deutscher Ingenieure*, dealing with vertical v. horizontal engines for stationary purposes, insisting that maximum efficiency can only be obtained with the vertical engine. 2000 w. Engng—Jan. 13, 1899. No. 25383 A.

Testing.

Engine and Boiler Testing. Henry W. Spangler. On the value of commercial testing and the methods of making the tests. The subject is discussed in detail. 6300 w. Pro of Engs' Club of Phila—Jan., 1899. No. 25177 D.

Theory.

The Mathematical Theory of the Steam Engine (Principes de la Théorie Mathématique de la Machine à Vapeur.) J. Nadal. An elaborate treatise and review of existing theories. 18,000 w. Rev de Mecanique—Nov. and Dec., 1898. No. 25427 each H.

Valves.

How to Set Valves. Ira A. Moore. Gives careful directions showlng that there is nothing very perplexing in the work. 4000 w. Loc Engng—Jan., 1899. No. 25000 C.

Waste Heat.

Utilization of the Waste Heat from Coke Ovens. M. Soulary. From a communication to the Société de l'Industrie Minerale. A record of results obtained in current working. Concludes that a well-designed water-tube boiler gives as good a yield as one of multitubular type, without the many disadvantages, and that it affords a greater measure of safety. Ill. 7500 w. Col Guard—Jan. 6, 1899. No. 25290 A.

MISCELLANY.

Engineers.

A Talk to Young Engineers. W. A. Truesdell. On the present opportunities for acquiring an education, and its advantages to the engineer; the qualifications needed and the conditions of success. 8000 w. Wisconsin Engr—Jan., 1899. No. 25201 D.

The Status of the Engineer. J. S. Walker. Abridged address of the president of the Engineering Assn. of the South, delivered at Nashville, Tenn. 2700 w. Am Mach—Jan. 12, 1899. No. 25183.

Pumps.

Driving Pumps by Compressed Air. William Cox. Presents the conditions which must be fulfilled so that the best results may be obtained. 1000 w. Compressed Air—Jan., 1899. Serial. 1st part. No. 25135.

Refrigeration.

A Series of Tests of the Refrigerating Plant in the Steam Engineering Laboratory of the University of Wisconsin. Walter Alexander, William H. Kratsch, Wallace F. Macgregor. Briefly reviews the history of ice-making from the earliest times, and the refrigerating systems and machines, giving the results of a series of tests conducted to determine the comparative efficiencies, with pressures varying from 140 to 220 pounds. 3500 w. Wisconsin Engr—Jan., 1899. No. 25204 D.

Electrical Equipment of a Modern Refrigerating Plant. An illustrated description of the refrigerating plant of the Manhattan Refrigerating Co., in New York city. 3000 w. Am Elect'n—Jan., 1899. No. 25561.

Practical Tests. Alfred Siebert. Discussing the making of approximate tests by the engineer with appliances at hand, to determine the results of the coal used, and the work of pumps, engines and refrigerating machines. 2700 w. Ice & Refrig—Jan., 1899. Serial. 1st part. No. 25017 C.

The Cincinnati Oyster and Fish Co. Illustrates and describes the modern, up-to-date plant of the Triumph Ice Machine Co. 2500 w. Ice & Refrig—Jan., 1899. No. 25016 C.

The Refrigerating Plant in the City Markets of Vienna. (Die Kühlanlage in der Städtischen Grossmarkthalle in Wien.) Joh. Hermanek. A full account of the manner in which a uniformly low temperature is maintained in the vaults of the market at Vienna, by the forced circulation of cooled air. Zeitschr d Oesterr Ing u Arch Ver—Jan. 6, 1899. No. 25479 B.

Review.

Mechanical Engineering. The annual editorial review of this branch reports a very uneventful year and gives some of the reasons. 5200 w. Engr, Lond—Jan. 6, 1899. No. 25275 A.

MILITARY ENGINEERING.

Battleships.

A New Russian Battleship. Illustration and dercription of the vessel being built at the shipyard of Messrs. Cramp & Co., Philadelphia, U. S. A. 1500 w. Engr., Lond--Dec. 30, 1898. No. 25158 A.

The Battleships of 1899. Illustrated description of the five fine vessels now being completed in American ship-yards. 2500 w. Naut Gaz—Jan. 5, 1899. No. 25096.

British Navy.

British Naval Progress. Gives information concerning the new work to be given out by the Admiralty to private contractors, and reviews the progress made with warship building. 2800 w. Engng—Dec. 23, 1898. Serial. 1st part. No. 25061 A.

The British Navy. A review of the British navy, noting its best features, and also its defects. 3400 w. Ill Car & Build—Jan. 6, 1899. No. 25298 A.

Destroyer.

The Torpedo-Boat Destroyer "Ikadsuche" for the Imperial Japanese Navy. Report of the preliminary trial giving reproduction of a photograph taken when the vessel was traveling over 31 knots. 450 w. Engng—Dec. 30, 1898. No. 25152 A.

Fire-proofing Wood.

A Process of Fire-proofing Wood to Be Used for the Woodwork of War Vessels. C. J. Hexamer. Describes process of impregnating the wood with soluble glass. 2000 w. Jour Fr Inst—Jan., 1899. No. 25128 D.

Guns.

Siege Guns at the Washington Arsenal. Illustrations of two types of siege guns, with particulars. 800 w. Sci Am—Jan. 21, 1898. No. 25341.

The Test of the Gatling Cast Steel 8-Inch Gun. Report of Dr. John N. Stockwell of an investigation of the effects of cooling on the strains of the different parts of the gun. 1400 w. Sci Am Sup—Jan. 21, 1899. No. 25344.

Maxim Guns.

The Tactical Applicability of the Maxim Machine-Gun. A. v Boguslawski, in *Kriegstechnische Zeitschrift*. Concludes the guns adapted to the uses of cavalry but of doubtful effect when employed by infantry. 2500 w. Sci Am Sup—Jan. 14, 1899. No. 25194.

Naval Engineering.

The War's Teaching in Naval Engineering. George W. Melville. The topics specially discussed are the importance of coal, water, repair-ships, uniform design of machinery, water-tube boilers, triple screws, speed, tests and training. The highest praise is given the personnel of the engineers corps. 4000 w. Stevens Ind—Jan., 1899. No. 25523 D.

Naval Experience.

Readings from Experience in Naval Engineering. George W. Melville. A review, by the Engineer in Chief of the United States Navy, of the lessons learned in the engineer's department by experience in the recent war with Spain. It is full of information, hitherto unpublished, of great interest. Serial. 1st part. 3500 w. Engineering Magazine—Feb., 1899. No. 25-432 B.

Naval History.

Naval History of the United States of America. Part first reviews the earliest history of the U. S. Navy to the breaking out of the revolutionary war. 2500 w. Naut Gaz—Jan. 5, 1899. Serial. 1st part. No 25097.

Ordnance Factories.

The Management of Ordnance Factories.

Editorial discussion of the question of civil as against military control. 2200 w. Engng—Dec. 30, 1898. No. 25153 A.

Sheathing.

Sheathing Warships. G. E. Walsh. Considers the advisability of using copper sheathing, discussing the objections, and giving the experience of other nations. 1200 w. N Am Rev—Jan., 1899. No. 24980 D.

Soudan Campaign.

Gunboats and Railways in the Soudan Campaign. Illustrates and describes these gunboats and the method of conveying them by rail around impassable rapids. 1200 w. Sci Am—Jan. 14, 1899. No. 25191.

War Material.

War Material. Editorial review of the progress made during 1898, and the lessons learned from the Spanish-American war. 1800 w. Engr, Lond—Jan. 6, 1899. No. 25279 A.

Weapons.

The Shot-Gun, Its Origin, Evolution and Present Status. (Le Fusil de Chasse, son Origine, ses Transformations, sa Situation Actuelle.) Report by M. E. Polonceau to the Société d'Encouragement pour l'Industrie Nationale upon the work of M. Nouvelle. Interesting data of the development of fire-arms, with statistics of the present French import and export trade in guns. 1300 w. Bulletin de la Société d'Encour—Dec., 1898. No. 25402 G.

MINING AND METALLURGY.

COAL AND COKE.

American Coal.

See Economics and Industry, Commerce and Trade.

Anthracite.

Anthracite Mining During 1898. A history of the progress in Pennsylvania and of the efforts to overcome trade difficulties. 2200 w. Mines & Min—Jan., 1899. No. 25124 C.

Mining Anthracite. A letter from W. S. Gresley containing suggestion for improved method of taking out all the coal on heavy pitches. Ill. 900 w. Mines & Min—Jan., 1899. No. 25113 C.

Briquettes.

Coal Briquettes in Wales. An account of this industry which is conducted on an extensive scale. 2000 w. U. S. Cons Repts, No. 327—Jan. 18, 1899. No. 25325 D.

British Coal.

The Coal Trade in 1898. Report of Northumberland, Durham, Lancashire, Yorkshire, Derbyshire and Nottinghamshire, South Staffordshire, South Wales and Monmouthshire, Scotland, and London. 8500 w. Col Guard—Jan. 6, 1899. No. 25288 A.

Coal Consumption.

Consumption of Coal for Steam at the Anthracite Collieries. A. D. W. Smith. Statistics are given showing that the Wyoming region, in 1897 used coal for steam amounting to 7 per cent. of its marketed product, and the balance of the region used 14 per cent. 1200 w. Eng & Min Jour—Jan. 21, 1899. No. 25363.

Coal Mining.

Indiana, Illinois, and Iowa Coal Mining in 1898. Hugh Murray. The condition of the business and the arrangement of scale of wages with the miners. 2000 w. Mines & Min—Jan., 1899. No. 25118 C.

Coal Testing.

Tests of Coal for Locomotives. William Garstang. Extracts from a paper read at the Dec. meeting of the Western Ry. Club. On the mode of procedure and results obtained from road tests on Big Four Ry., and from laboratory tests conducted at Purdue Univ. 2300 w. Ry & Engng Rev—Jan. 14, 1899. No. 25267.

Coal Working.

Systems of Working Coal. J. T. Beard. Conditions which determine the system by which a field should be worked. Modifications of the two general systems of extraction, making these systems applicable to all conditions of roof, floor, coal, depth, inclinations, clearage, gas, etc. Ill. 3500 w. Mines & Min—Jan., 1899. Serial. 1st part. No. 25106 C.

Coke and Briquettes.

Domestic Coke and Briquettes from Retort Coke Ovens. R. M. Atwater. Read at meeting of the Ohio Inst. of Min. Engs. Discusses the prospect of using Ohio coals for blast furnace coke; the effect of fine grinding, the retort oven coke, with details of the operation, and the making of briquettes. 3300 w. Ir Trd Rev—Jan. 26, 1899. No. 25592.

Coke Manufacture.

The Manufacture of Coke. A detailed consideration of the systems of importance now used in England, dealing with the results obtained. This article presents the Otto system. Ill. 2800 w. Col Guard—Jan. 13, 1899. Serial. 1st part. No. 25387 A.

Coking.

Coking Lean Coals with the Aid of Mechanical Stamping Appliances. Oscar Simmersbach, in *Stahl und Eisen.* An interesting review of the mechanical appliances used in Germany, with the aim of hardening coals relatively low in bituminous matter. Ill. 2800 w. Ir Age—Dec. 29, 1898. No. 24963.

Colliery Sinking.

An Account of the Maypole Colliery Sinking, Wigan. A. H. Leech. Abstract of a paper read before the British Assn. of Mining Students. Explains the conditions prevailing in this locality, and describes the sinking, which was a very difficult work. Ill. 3000 w. Ir & Coal Trds Rev—Jan. 13, 1899. No. 25379 A.

Comparison.

Charcoal and Coke. Notes wherein they resemble and differ from each other. Cleavage in coke and metals. Ill. 1500 w. Mines & Min—Jan., 1899. No. 25108 c.

Dakota.

Coal in North Dakota. E. J. Babcock. A description of the extent and location of the formations and the various qualities of the coal. 1000 w. Mines & Min—Jan., 1899. No. 25110 c.

Miike Coalfield.

The Miike Coalfield and the Largest Collieries in the East. States the general conditions existing in Japan, and considers the more important coal-fields. 7500 w. Ir & Coal Trds Rev—Jan. 6, 1899. No. 25287 A.

Ohio.

Jackson County Coal Mines. Andrew Roy. The development of a high-grade Ohio coal field and a history of its exploitation. 1000 w. Mines & Min—Jan., 1899. No. 25111 c.

Saint-Eloy Colliery.

Incline for Large Output at the Saint-Eloy Colliery. M. H. de Lachapelle. Communicated to the Société de l'Industrie Minérale. Illustrates and describes a new incline with carrying truck of special type. 2000 w. Col Guard—Dec. 23, 1898. No. 25056 A.

Scotch Coals.

Chemical Notes on Scotch Coals. W. C. Anderson. Abstracted from the Proceedings of the Glasgow Philosophical Soc. Describes the varieties, gives an estimate of the coking power, oxidation, and the effect of heat. 2400 w. Gas Wld—Jan. 14, 1899. No. 25510 A.

Sizing.

The Effect of Sizing on the Removal of Sulphur from Coal by Washing. Charles C. Upham. Calls attention to an element in the preliminary treatment, which is very generally neglected in the washing of coal, and of importance in coke-making. 1400 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24972 D.

Washington.

Coal Mines of Washington. A description of the mines at Carbonado, Wilkeson and Burnett, in Pierce County. The peculiarities of the formation in which the coal is found and some instances in which advantage has been taken of them in mining the coal. Ill. 2200 w. Mines & Min—Jan., 1899. No. 25112 c.

Western Coal.

Data as to the Value of Western Coal. Tabulated statement of the principal results of government tests, with analyses of a number of coals. 500 w. R R Gaz—Jan. 13, 1899. No. 25214.

COPPER.

Copper.

See Electrical Engineering, Electrochemistry.

Copper Market.

Boom in Copper Market. On the present condition of the copper market, giving articles reprinted from the *N. Y. Sun* and *N. Y. Tribune*. 2000 w. W Elect'n—Jan. 14, 1899. No. 25252.

Mine.

Peak Downs Copper Mine. From the *Brisbane Courier*. An account of the reopening of a mine worked with much success many years ago. 1100 w. Aust Min Stand—Dec. 15, 1898. No. 25302 B.

Wyoming.

Wyoming Copper. E. P. Snow. Brief review of the districts known to be rich in copper within the limits of this State. 1200 w. Min Rept—Dec. 29, 1898. No. 25020.

GOLD AND SILVER.

Australia.

The Alluvial Deposits of Western Australia. T. A. Rickard. Describes the geology and physiography of these gold fields, distribution, dry blowing machinery, water supply and theories of the origin of the deposits. Ill. 9900 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24967 D.

California.

The Mother Lode of California. Arthur Lakes. A description of what is supposed to be the largest vein system in the world. Its location, position, and extent; the peculiarities of its formations and the various kinds and qualities of the minerals. Ill. 4200 w. Mines & Min—Jan., 1899. No. 25107 c.

Colorado.

The Silver Pick Mine—Wilson, Colorado. M. B. Spaulding. A sketch of a mine presenting many novel features. 2800 w. Sch of Mines Qr—Nov., 1898. No. 25198 D.

Concentration.

Concentration After Lixiviation. Mall. W. Anderson. On the treatment of tellurium ores in the cyanide mills treating the refractory ores of the mines of Cripple Creek and vicinity. 1100 w. Min & Sci Pr—Dec. 31, 1898. No. 25080.

Deep Leads.

Victorian Deep Leads. Information of a comprehensive boring scheme, with brief accounts of the districts in which it is proposed to search for deep leads. 2000 w. Aust Min Stand—Nov. 24, 1898. No. 25042 B.

Fire Assaying.

Remarks on Fire Assaying of Gold-Bearing Materials. William Bettel. Discusses the losses of gold, collection of finely divided gold, and other points which affect the accuracy of results. 4500 w. Jour of Chem & Met Soc of S Africa—Nov., 1898. No. 25296 E.

Hauraki Goldfields.

Water-Supplies for Mining Townships on the Hauraki Goldfields. Recommendations of T. Perham, for supplying water for domestic uses and fire-extinction. 6500 w. N Z Mines Rec—Dec. 16, 1898. No. 25303 B.

Idaho.

Gold Mining at Gibbonsville, Idaho. Don

Maguire. Facts in regard to the history and prospects of an interesting mining town. 1800 w. Mines & Min—Jan., 1899. No. 25117 C.

Milling.

Milling of Rossland Ores. H. W. C. Jackson. A description of the British Columbia Bullion Extracting Company's Pelatan-Clerici Cyaniding plant. 1200 w. Can Min Rev—Dec. 31, 1898. No. 24996 B.

Mill Practice.

Mill Practice of the Utica Mills, Calaveras County, California. A description of the present practice in these mills. 5500 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24968 D.

Placer Gold.

Origin of Placer Gold in the Drains of the Divide. A. M. Welles. Presents the writer's explanation of the occurrence of gold in Cherry Creek, its tributaries, and other water-ways in Colorado. 2200 w. Min Rept—Dec. 22, 1898. No. 24991.

Precipitation.

A Zinc Process for Precipitating Gold from Weak Solutions. Discussion of the paper by T. L. Carter. 4000 w. Jour of Chem & Met Soc of S. Africa—Nov., 1898. No. 25297 E.

Slimes.

Filter-Press Treatment of Gold Ore Slimes. William McNeill. Illustrates and describes this method of treatment and gives the opinion that in many cases it will prove more advantageous than other methods. 2500 w. Eng & Min Jour—Dec. 31, 1898. No. 24955.

IRON AND STEEL.

Blast Furnaces.

Note on Slips and Explosions in the Blast-Furnace. F. B. Richards. Illustrated description of an explosion occurring where the ores from the Lake Superior districts are used, given in the hope that suggestions of theory as to the cause may be elicited. 800 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24970 D.

Cast Iron.

Cast Iron in Railway Practice. G. R. Henderson. Reports experiments and analyses, with a study of the needs of certain classes of castings and the chemical constituents needed to meet the requirements. Ill. 1800 w. Am Eng & R R Jour—Jan., 1899. No. 24998 C.

Foundry Iron.

See Mechanical Engineering, Foundries.

French Iron Trade.

See Economics and Industry, Commerce and Trade.

Hot-Blast.

Hot Blast-Stoves for Pig-Iron Works. Joseph H. Harrison. Abstract of paper read at meeting of the Cleveland Inst. of Engs. On the merits of the Ford and Moncur hot-blast stoves. Also discussion. 3300 w. Col Guard—Dec. 23, 1898. No. 25057 A.

Iron Ore Trade.

See Economics and Industry, Commerce and Trade.

Iron Trade.

See Economics and Industry, Commerce and Trade.

Melting Iron.

See Mechanical Engineering, Foundries.

Steel Specifications.

Specifications on Structural Steel and Rails. Discussion by W. R. Webster, H. V. Wille, A. A. Stevenson, John Sterling Deans, Charles B. Dudley and Paul Kreuzpointner. 6000 w. Jour Fr Inst—Jan., 1899. No. 25125 D.

The Relations Between the Chemical Constitution and the Physical Character of Steel. William R. Webster. Investigation concerning the tensile strength of steel, quoting from various authorities and giving results of the writer's investigations. 12,000 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24975 D.

Steel Trade.

See Economics and Industry, Commerce and Trade.

Steel Works.

The Lorain Steel Company's Works, Ohio. Robert W. Hunt. An interesting illustrated account of the selecting of the site, the rapid building of substantial works, the arrangements for attractive homes for employes, &c., with detailed description of the plant. 4700 w. Engng—Jan. 6, 1899. Serial. 1st part. No. 25281 A.

The Works of the Illinois Steel Company, U. S. A. Describes the property and plants of the company, its business and resources in a general way, and particularly describes the largest plant, at Chicago. 4300 w. Engr, Lond—Dec. 23, 1898. Serial. 1st part. No. 25063 A.

Sulphide Ores.

The Treatment of Sulphide Ores. William Thomas. Read before the South Wales Inst. of Engs. Shows that all processes previously applied to these ores have proved disappointing and describes the treatment given at Tow Law, Weardale, Durham. 2400 w. Col Guard—Dec. 23, 1898. No. 25058 A.

MINING.

Alabama.

Alabama Mining in the Year 1898. A. H. Carpenter. A review of the progress of the coal and coke industry of the state. 1000 w. Mines & Min—Jan., 1899. No. 25123 C.

Automatic Doors.

Automatic Apparatus for Closing Levels in Mine Shafts. (Appareils Automatiques de Fermeture des Recettes dans le Puits de Mines.) H. Schmerber. Illustrated description of automatic doors operated by the passage of the cage, avoiding the danger of men or tram-cars falling down the shaft. 1500 w. Le Génie Civil—Dec. 24, 1898. No. 25414 D.

Boring.

The Raky Boring Apparatus. A. Lukaszewski, in *Oesterrichische Zeitschrift für Berg-und Hüttenwesen*. Illustrates and describes an improved percussion system which has worked well under trying conditions. 1200 w. Col Guard—Jan. 13, 1899. No. 25388 A.

California.

California as a Mining Country. Arthur Lakes. How it impresses a Coloradoan in regard to its general appearance and methods of working and treating the ores. 2300 w. Mines & Min—Jan., 1899. No. 25115 C.

Mining in California. J. R. Schuphaus A review of the general conditions surrounding the mining industry and its progress during 1898. 2200 w. Mines & Min—Jan., 1899. No. 25122 C.

Colorado.

Boulder Region, Colorado. Arthur Lakes. In regard to an examination made on a portion of it by an expert. 1600 w. Mines & Min—Jan., 1899. No. 25109 C.

Colorado Mining During 1898. Arthur Lakes. Some of the notable features of advancement and improvement made during the year. 1800 w. Mines & Min—Jan., 1899. No. 25119 C.

Electric Pumping.

Electric Mine-Pumping Plant. (Elektrische Betriebenen Wasserhaltung.) A description of a 750 h. p. underground electric pumping plant in the Maria Anna and Steinbach mines at Hontrop. 3500 w. Glückauf—Dec. 24, 1898. No. 25494 B.

Explosions.

Coal and Explosions. (Les Explosions dans les Mines de Houille et les Conséquences d'un Excés d'Aérage Artificiel.) Franz Büttgenbach. A short résumé of theories on this subject. 1500 w. Rev Univ des Mines—Dec., 1898. No. 24442 G.

Lake Superior.

Lake Superior Iron and Copper. Horace J. Stevens. The history of a prosperous year in the mining business of this district. 2000 w. Mines & Min—Jan., 1899. No. 25121 C.

Lewis River.

The Headwaters of the Lewis River. A. Thurston Heydon. A study of the country made by the writer while prospecting. 1200 w. Min & Sci Pr—Jan. 21, 1899. No. 25529.

Mine Drainage.

The "Copper Water" of Butte. George S. Binckley. The conditions existing at the Anaconda mines and the means of overcoming the corrosive action. 800 w. Min & Sci Pr—Jan. 21, 1899. No. 25528.

Mine Plant.

See Electrical Engineering, Power Application.

Mine Surveying.

Rocky Mt. Mine Surveying. Joseph Barrell. Some convenient methods especially suited to the conditions. Plumbing vertical shafts, surveying inclined shafts, methods for instruments commanding any vertical angle, also for those without extra attachments. Ill. 5000 w. Mines & Min—Jan., 1899. No. 24105 C.

The Evolution of Mine Surveying Instruments. Dunbar D. Scott. Historical review of the development of mine-surveying instruments, with numerous illustrations. 16,500 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24966 D.

Mistakes.

Mistakes in Mining. Edmund B. Kirby. Calling attention to mistakes and waste in mining and working of ores. 2000 w. Min & Sci Pr—Dec. 31, 1898. No. 25078.

Montana.

The Cottonwood Mine at Stockett, Montana. J. E. Stockett. Describes the mine and the haulage arrangements used. 1500 w. Mines & Min—Jan., 1899. No 24116 C.

Pumping Machinery.

Mine Pumping Machinery. (Les Machines d'Epuisement Souterraines.) P. Habets. A general discussion of self contained mine pumps as distinguished from those mechanically driven from the surface. 5500 w. Rev Univ des Mines—Dec., 1898. No. 24443 G.

Tunneling.

Note on the Cost of Tunneling at the Melones Mine, Calaveras County, California. W. C. Ralston. Gives the cost of driving an adit at the Melones mine in 1898, and comparison with the cost of similar work at the Hogsback mine in 1888. 2000 w. Trans of Am Inst of Min Engs —Dec., 1898. No. 23974 D.

Utah.

Mining in Utah. Don Maguire. Reviews the progress in the development of the various mineral properties of the state during 1898. 2500 w. Mines & Min—Jan., 1899. No. 25-120 C.

Ventilation.

The Study of Mine Ventilation. On the importance and interest in this study and the need of a recent and able treatise on this subject. 3200 w. Col Guard—Jan. 13, 1899. No. 25-386 A.

MISCELLANY.

Alloys.

Application of the Solution Theory to Metallic Alloys. (Beiträge zur Anwendung der Lösungstheorie auf Metalllegirungen.) Hanns von Jüptner. A discussion of the extension of the solution theory as developed by the author in connection with iron and steel, to other metallic alloys; with data from the experiments of Osmond, Le Chatelier and others. 3000 w. Stahl und Eisen—Jan. 1, 1899. No. 25493 D.

Metallic Alloys and the Theory of Solution. Charles T. Haycock. Abstract of a discourse delivered at the Royal Inst. Brief statement of results in investigating some of the properties of alloys in the liquid state. 1400 w. Nature—Dec. 29, 1898. No. 25147 A.

Aluminum.

The Present Position of Aluminum. The uses to which the metal has been put, especially those having regard to the requirements of the engineer. 1800 w. Prac Engr—Dec. 30, 1898. No. 25149 A.

The Properties of Aluminum. (Sur les Propriétés de l'Aluminum.) A. Ditte. A statement of the chemical properties of the metal, its resistance to attack by oxygen and acids. The conclusion is drawn that, before it is used for culinary or military utensils, the subject should be more fully studied. 1500 w. Bulletin de la Société d'Encour—Dec., 1898. No. 25406 G.

Annual Review.

Review of the Mineral and Metal Production for the year 1898. The usual important review of this publication, giving information of value and interest. 70,000 w. Eng & Min Jour—Jan. 7, 1899. No. 25140.

The Mineral Industry in 1898. Additional information concerning Alaska, Alabama, Arizona, Arkansas, California, Colorado, Kansas, Kentucky, Maryland, N. Carolina, S. Dakota, Vermont, Washington, W. Virginia, Wyoming, British Columbia and Utah. 21,500 w. Eng & Min Jour—Jan. 14, 1899. No. 25242.

Antifriction.

Study of White Alloys Called Antifriction. G. Charpy. Describes researches made to obtain a methodical classification to assist in deciding which alloy should be used in each individual case. Ill. 8500 w. Metallographist—Jan., 1899. No. 25255 E.

Antimony.

The Metallurgy of Antimony. A. Selwyn Brown. Gives a brief description of the early method of reduction, and the English process, now most largely used. Also outlines other methods used where conditions are favorable. 2300 w. Aust Min Stand—Nov. 24, 1898. No. 25041 B.

Arrastra.

How to Build and Operate an Arrastra. E. L. Ballou. Illustrated description. 3000 w. Min & Sci Pr—Jan. 14, 1899. No. 25365.

Brass.

Brass-Melting Furnaces. C. Vickers. Treats of their design, construction, and operation. Ill. 1400 w. Serial. 1st part. No. 25322.

Bronzes.

A Study of the Microstructure of Bronzes. A. E. Outerbridge, Jr. Investigations and conclusions are given, with photo-micrographs of specimens examined. Discussion. 5000 w. Jour Fr Inst—Jan., 1899. No. 25126 D.

Bye-Products.

The Recovery of Bye-Products. Editorial on the changed conditions which makes it doubtful whether the recovery of many of these waste products will pay. 1600 w. Engng—Jan. 6, 1898. No. 25285 A.

Cuba.

The Mineral Resources of Cuba. Jennings S. Cox, Jr. A well illustrated description of the mineral resources of the island, with special reference to their exploitation and their present development. The labor problem in Cuban mining is also discussed at some length. 3500 w. Engineering Magazine—Feb., 1899. No. 25436 B.

Hubnerite.

Hübnerite in Arizona. William P. Blake. Describes the occurrence in this new locality. Ill. 1000 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24971 D.

Kytchtym Medal.

The Kytchtym Medal. Dr. Persifor Frazer. This medal was one of the souvenirs given on the Ural excursion of the VIIth International Geological Congress. Describes the process of manufacture and the constitution of the metal. 600 w. Trans of Am Inst of Min Engs—Dec., 1898. No. 24973 D.

Life Saving.

Sanitary and Life Saving Appliances of the Shamrock Mine at Herne. (Sanitäts- und Rettungseinrichtungen auf der Zeche Shamrock bei Herne.) A very excellent account of the life saving appliances and system as used in the collieries of Westphalia; being an address before the society of mine superintendents at Herne, by G. A. Meyer. 5000 w. Glückauf—Jan. 1, 1899. No. 25496 B.

Manganese.

Manganese in Iron Ores and Pig Iron. R. R. Tatlock and R. T. Thomson. Read before the West of Scotland Iron and Steel Inst. Gives tabulated results of investigations of the different ores of commerce and the conclusions reached. 2000 w. Col Guard—Jan. 20, 1899. No. 25626 A.

Metallography.

The Progress of Metallography in 1898. Albert Sauveur. An outline of important recent contributions to the knowledge of metals and alloys. 2400 w. Metallographist—Jan., 1899. No. 25254 E.

Nickel.

Some Notes on the Recovery and Refining of Nickel. Sherard Cowper-Coles. Reviews briefly some methods for the treatment of nickel ore by electro-metallurgical methods. 1700 w. Elec Rev, Lond—Dec. 23, 1898. No. 25053 A.

Ores.

Treating Hard Low-Grade Ores. Walter J. May. Describes processes applicable to ores where disintegration, cleaning and separation are all that is necessary to render the ore fit for use or sale. 1800 w. Prac Eng—Dec. 23, 1898. No. 25051 A.

Plate Glass.

The Saint Gobain Plate Glass Manufactory. Illustrated description of the details of plate-glass making. 1800 w. Sci Am Sup—Jan. 14, 1899. No. 25195.

Quarries.

The Welsh Slate Quarries. Describes some of the important quarries and the systems of working. 2400 w. Eng & Min Jour—Dec. 31, 1898. No. 24954.

Tasmania.

The Minerals of Eastern Tasmania. H. Grout. Describes the formation and minerals of this district. 2700 w. Aust Min Stand—Dec. 8, 1898. Serial. 1st part. No. 25301 B.

Tin Mines.

The Tin-Mines of Bolivia. Charles S. Pasley. Paper read before the Inst. of Min. & Met., London. Describes the location and formation. 1400 w. Col Guard—Jan. 6, 1899. No. 25289 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene. Vivian B. Lewes. A series of 4 Cantor lectures. Gives the history of this gas, its analysis, properties, experiments, &c. 20,000 w. Jour Soc of Arts—Dec. 23 and 30, 1898, Jan. 6 and 13, 1899. Serial—4 parts. No. 25094 each A.

Cubic Feet of Acetylene to a Pound of Carbide. H. F. Fuller. An explanation of the theoretical combination and the calculations by which it is ascertained that the most acetylene that can be obtained from one pound of carbide is 5.584 cubic feet. 1400 w. Dom Engng—Jan., 1899. Serial. 1st part. No. 25500 C.

The Acetylene Standard of Light. H. E. Clifford and J. S. Smyser. A statement of results obtained in a recent investigation of some of the photometric properties of the acetylene gas flame, with an explanation of the apparatus used. Ill. 1500 w. Tech Quar—Dec., 1898. No. 25319 E.

Bunsen Burners.

The Lecomte System of Bunsen Burner Construction. On the work of M. A. Lecomte in this field. His low-pressure economical bunsen burner received recently a prize of 500 frs. 2000 w. Jour Gas Lgt—Dec. 27, 1898. No. 25090 A.

Equer's Apparatus.

Equer's Apparatus for Manufacturing Gas. A summary of the scope of this apparatus, with illustrations. 1500 w. Am Gas Lgt Jour—Jan. 23, 1899. No. 25502.

Etherion.

On the Supposed New Gas, Etherion. Sir William Crookes, in *Chemical News*. Results of experiments are given in support of the opinion that etherion is nothing more than aqueous vapor. 2500 w. Am Gas Lgt Jour—Jan. 2, 1899. No. 24992.

Gas Contamination.

The Contamination of Gas in Holders. M. Ymonet, in the *Journal de l'Eclairage au Gaz*. General observations on the causes of the contamination. 1200 w. Jour Gas Lgt—Jan. 10, 1899. No. 25333 A.

Gas-Holder Failure.

The Destruction of a Mammoth Gas Holder. An account of the collapse of the new gas-holder of the Consolidated Gas Co., in New York. Ill. 2400 w. Ir Age—Dec. 22, 1898. No. 24960.

The Gas Tank Failure in New York. Letters on this subject from Robert W. Prosser, George Rae, and W. H. Breithaupt. 2400 w. R R Gaz—Jan. 27, 1899. No. 25553.

Why the Gas Tank Failed. George Rae. Gives the opinion that the failure was due to faulty construction, or defects in design. 1600 w. Ill. R R Gaz—Jan. 6, 1899. No. 25074.

Gas Indicator.

The Lyncker and Schropp Gas Indicator. From *Oesterreichische Zeitschrift für Berg und Hüttenwesen*. Illustrates and describes an apparatus for use in collieries, ships' bunkers, gas works, &c., based on the principle of the diffusion of gases. 900 w. Col Guard—Dec. 30, 1898. No. 25159 A.

Gas Supply.

Gas Supply. Editorial summary of the year 1898. 1200 w. Engr, Lond—Jan. 6, 1899. No. 25278 A.

Italian Conference.

The Conference of Italian Gas Managers. Notes on the visits paid to the gas works in Turin, and to the General Exhibition then being held in the city. 1800 w. Jour Gas Lgt—Dec. 27, 1898. No. 25089 A.

Mains.

Mains and Main-Laying. Comments on Mr. Forstall's paper read before the Am. Gas. Lgt. Assn. 1800 w. Jour Gas Lgt—Jan. 3, 1899. No. 25251 A.

Oxygen.

The Stuart Process for the Production of Oxygen. Romyn Hitchcock. Describes the development of this process and the application of oxygen to the manufacture of coal gas. Part first is an account of the various processes that have been tried for the economical production of oxygen on a large scale. 1800 w. Eng & Min Jour—Jan. 21, 1899. Serial. 1st part. No. 25364.

Pintsch Gas.

Pintsch Gas Plant, Manhattan Elevated Railroad, New York. Illustrated detailed description of the plant installed at 159th St., New York City, for supplying daily 1100 cars of the Manhattan Elevated Railroad. 2200 w. Am Eng & R R Jour—Jan., 1899. No. 24997 C.

Retrospect.

A Retrospect of the Year 1898. A review of the industry of gas-lighting in Great Britain, with some reference to artificial lighting by other means. 4500 w. Jour Gas Lgt—Dec. 27, 1898. No. 25086 A.

Returns.

The Gas Undertakings Returns. On the nature of the changes made and the principal totals as shown in the recently issued report for the United Kingdom. 1200 w. Jour Gas Lgt—Dec. 27, 1898. No. 25088 A.

Solubility.

The Solution of Solids and Liquids in Gases. M. P. Villard. Experiments showing that gas possesses sometimes considerable dissolving power. 1500 w. Am Gas Lgt Jour—Jan. 2, 1899. Serial. 1st part. No. 24993.

Water Gas.

Observations Upon Water-Gas. H. Bunte. Considers the Dellwick process, Strache's system, the danger of explosion, and the future non-luminous gas. 2400 w. Gas Wld—J 14, 1899. No. 25509 A.

The Theory of the Water-Gas Process. Abstract translation of a contribution by H. Luggin to the *Journal für Gasbeleuchtung*. Details theoretical considerations and experimental facts set forth by Hoitsema, and discusses the evils consequent of too low a temperature in the generator. 3000 w. Jour Gas Lgt—Dec. 20, 1898. No. 24994 A.

SEWERAGE.

Baltimore.

The Sewerage of Baltimore. Kenneth Allen. Read before the Am. Soc. of Munic. Imp. Describes the present situation and outlines the proposed system. 2200 w. Munic Engng—Jan., 1899. No. 25008 C.

Sewage.

Modern Processes of Municipal Sewage Treatment. (Die Behandlung Städtischer Spüljauche mit Besonderer Berücksichtigung Neuerer Verfahren.) A paper read before the German Sanitary Association by Dr. Dunbar, discussing the more recent chemical methods of treating sewage, with reference also to the bacterial and sedimentation processes. 4500 w. Gesundheits Ingenieur—Dec. 15, 1898. No. 25484 B.

Sewage Disposal.

A Novel Method of Sewage Disposal, Especially Designed for the City of Toronto. C. G. Horetzky. Details of the method adopted with cost of construction and annual maintenance. 2500 w. Can Engr—Jan., 1899. No. 25329.

Sewage Disposal. H. deB. Parsons. Gives a brief general description of properly designed disposal works, with information bearing on the subject of purification of water, &c. 2800 w. Stevens Ind—Jan., 1899. No. 25524 D.

Sewage Disposal by Bacteria Beds and the Septic Tank. Paper by George Thudichum on the conditions governing the use of these systems. 3300 w. Eng Rec—Dec. 31, 1898. No. 24987.

The Clinton, Mass., Sewage Disposal System. Illustrated description of a pumping plant, reservoirs, and filter beds built by the Metropolitan Water Board to prevent the pollution of the Nashua River. 1800 w. Eng Rec—Jan. 14, 1899. No. 25234.

STREETS AND PAVEMENTS.

Macadam.

Disputed Points in Connection with the Construction and Maintenance of Macadamized Roads. H. Irwin. A discussion on this subject by members of the Am. Soc. of Civ. Engs., gave diverse opinions, and the aim of the paper is to ascertain how far these opinions might be accounted for by difference in local conditions. 2300 w. Can Engr—Jan., 1899. Serial. 1st part. No. 25330.

WATER SUPPLY.

Berlin.

The Pumping Machinery for the Berlin Waterworks at Müggelsee. (Pumpmaschine für die Berliner Wasserwerke am Müggelsee.) Illustrated description of horizontal compound pumping engines, with plans, elevations, and photographic view of interior of engine room. 1200 w. 1 plate. Zeitschr d Ver Deutscher Ing—Dec. 17, 1898. No. 25460 D.

Color of Water.

Methods for the Determination of Color and the Relation of the Color to the Character of the Water. Frederick S. Hollis. A study of the causes of increase and change of color, with methods of determination of the color. Also discussion. 7000 w. Jour N E Water Wks—Dec., 1898. No. 25293 F.

Control.

The Derwent and Ashop Water Supply Schemes. Leicester, Sheffield, and Derby are each contending for the entire control of the head waters of these rivers for the object of supplementing their supplies. The article describes the schemes as at present suggested, and the claims put forward by each town. Ill. 2500 w. Engr, Lond—Dec. 23, 1898. No. 25065 A.

Coolgardie Pipe Line.

The Contract for the Coolgardie Steel Pipe Line, Western Australia. Particulars regarding the contract and the pipe to be used for this line 328 miles long to be built by the government to supply water to the mining district. 1500 w. Eng News—Dec. 29, 1898. No. 24952.

Croton Dam.

The New Croton Dam. Illustrated description of the methods adopted in putting in the foundations. 1100 w. Eng Rec—Jan. 7, 1899. No. 25099.

Early Methods.

Early Methods of Collecting, Storing, and Distributing Water. W. R. Hill. Introductory remarks with description of the earliest construction work is given in part first. 2500 w. San Rec—Dec. 23, 1898. Serial. 1st part. No. 25129 A.

Electrolysis.

An Example of Electrolysis of Water Mains in Brooklyn, N. Y. Illustrates a specimen of the corroded pipe, and quotes from a report by an expert engineer. 1200 w. Eng News—Jan. 26, 1899. No. 25547.

Fire Service.

Description of the Separate High Pressure Fire-Service System of Providence. R. I. Edmund B. Weston. Gives plan showing pipe and hydrants, and illustrates the design of joints and the manner of securing curved pipe. 3000 w. Jour N E Water Wks—Dec., 1898. No. 25292 F.

Hydrant Rentals.

A Side Light on Hydrant Rentals. Review of a decision of the Supreme Court of Nebraska making all contract provisions in a water ordinance void unless clearly mentioned in the title. 800 w. Eng Rec—Jan. 14, 1899. No. 26233.

Jamaica.

The Normal Chlorine of the Water Supplies of Jamaica. Ellen H. Richards and Arthur T. Hopkins. Explains the topography of the island, and its position in the path of the trade winds with the effects resulting; gives the method of collecting samples for analysis, and a table of analyses made, with remarks. 4400 w. Tech Quar—Dec., 1898. No. 25317 E.

Philadelphia.

The Water-Supply Problem of Philadelphia. Reviews a report by J. W. Ledoux on schemes for improving the supply and his estimates of the cost of filtering. 1800 w. Eng Rec—Jan. 7, 1899. No. 25098.

Pollution.

The Prevention of Pollution of Streams and Rivers. Part of a paper read by Dr. Childs at the recent Sanitary Congress at Birmingham, Eng. On the defects in the Rivers' Pollution Act, and needed amendments; the methods employed by the joint committees, and results attained. 3800 w. Builder—Dec. 31, 1898. No. 25164 A.

Pumping.

Possibilities of Economy in Pumping Engines. George H. Barrus. Condensed abstract of paper read at meeting of the New England Water-Works Assn. Reviews a comparative examination of five tests of triple-expansion pumps. 800 w. Eng Rec—Jan. 28, 1899. No. 25589.

See Mechanical Engineering, Steam Engineering.

Pure Water.

Principles Involved in the Selection of Water Supply. (Grundsätze bei der Beurteilung von Trink- und Nutzwasser.) Report of a committee of the Society of German Chemists, giving the questions which should be answered in critically examining any proposed source of water supply. 3500 w. Gesundheits Ingenieur—Dec. 31, 1898. No. 25487 B.

Review.

Water and Sanitary Affairs. A review of the principal events of the year 1898 in England. 3700 w. Jour Gas Lgt.—Dec. 27, 1898. No. 25087 A.

Surface Water.

Surface Water Supplies of Massachusetts. John C. Haskell. Some of the reasons why surface water supplies are not desirable, with report of the waters of the state named. 2000 w. Jour N E Water Wks—Dec., 1898. No. 25291 F.

Vienna.

The Pumping Machinery of the Breitensee Waterworks. (Die Maschinenanlage des Wasserwerkes von Breitensee.) C. Budil. A very fully illustrated account of this important station of the Vienna water supply system, showing especially the application of the Riedler system of mechanically operated water valves. 3500 w. 2 plates. Zeitschr d Ver Deutscher Ing—Jan. 7, 1899. No. 25468 D.

Water Filter.

An Improved Filter for Microscopical Water Analysis. Daniel D. Jackson. Illustrates and describes an invention of the writer the use of which has given very satisfactory results. 1500 w. Tech Quar—Dec., 1898. No. 25318 E.

Water Mains.

A Symposium on Pipe Lines. Reviews the papers on large cast-iron and riveted steel mains, and the salt-water fire-protection system of Boston, presented to the N. E. W. W. Assn. 1700 w. Eng Rec—Jan. 14, 1899. No. 25241.

Water Meters.

The Accuracy and Durability of Water Meters. John W. Hill. Report of examination by the writer of seventeen different meters, with discussion of tests by others, the construction features of meters, their durability, etc. Ill. 6500 w. Pro of Am Soc of Civ Engs—Jan., 1899. No. 24572 F.

Water Purification.

Application of the Anderson Process to the Water of the River Plate. (Aplicación del Procedimento Anderson á las Aguas del Río de la Plata.) Carlos Doynel. A comparison between sand filtration and the Anderson process, giving data of analyses and experiments made by a sanitary commission at Buenos Aires. 3000 w. La Ingeniera—Nov., 1898. No. 25407 E.

The Preparation of Water for Industrial Purposes, and the Purification of Discharge Water. (Die Aufbereitung der Fabrikationswässer vor dem Gebrauch und die Reinigung von Abwässern.) B. Schnackenburg. Giving methods of purification by filtration, neutralization, precipitation, &c., both before and after use. 2500 w. Gesundheits Ingenieur—Dec. 31, 1898. No. 25486 B.

Water Rates.

The New Water Rates in Milwaukee. Discussion of the first attempt to introduce a uniform rate for water, whether supplied in large or small quantities, or charged by meter or fixture schedules. 1200 w. Eng Rec—Dec. 31, 1898. No. 24982.

Watersheds.

The Desirability of Making Watershed Areas and Sanitary Districts Coterminous. R. E. Middleton. Reprinted from the *Journal of the Sanitary Inst.*, England. An able discussion of the subject. 7500 w. Jour N E Water Wks—Dec., 1898. No. 25294 F.

Water Supply.

Water Supply. Editorial yearly review of the events in the United Kingdom. 2200 w. Engr, Lond—Jan. 6, 1899. No. 25277 A.

Water Supply from the Lower Greensand at Leighton Buzzard. H. Bertram Nichols. Read at meeting of the British Assn. of Water-Works Engs. A statement of the conditions of the supply of the named town, with analysis of the water. Discussion. 6800 w. Jour Gas Lgt—Dec. 20, 1898. No. 24995 A.

Water Works.

Simla Water-Works. C. E. V. Goument. Illustrates and describes the new works. 2700 w. Ind & East Eng—Dec., 1898. No. 25368 D.

The New Duluth Water-Works. Illustrated description of the riveted steel in take with flexible and hook joints, pumping station, force main, frost boxes on bridges, and other features. 2800 w. Eng Rec—Jan. 21, 1899. No. 25352.

The U. S. Supreme Court on the Rights of a Private Water Company. A review of an important decision restraining a city from building works after granting a franchise to a company. 2500 w. Eng Rec—Jan. 28, 1899. No. 25581.

The Water-Works of Plymouth, England, Illustrates and describes two dams of unusual construction. 2000 w. Eng Rec—Jan. 28, 1899. No. 25584.

MISCELLANY.

Garbage.

Garbage Disposal. Arthur R. Reynolds. R Reynolds. Read before the Am. Soc. of Munic. Engs. A study concerning the wastes of Chicago, but having general application. Considers collection and disposal. 1600 w. Munic Engng—Jan., 1899. No. 25009 c.

Havana.

The Importance of Cleaning Havana. Editorial statement of the results in the past of its unsanitary condition. 1600 w. Eng Rec—Jan. 21, 1899. No. 25348.

The Sanitation and Public Works of Havana. Extracts from General Greene's review and from G. E. Hill's presentation of Col. Waring's views, with comments. 2200 w. Eng News—Jan. 12 1899. No. 15188,

The Sanitation of Havana. Extracts from the report of General Francis V. Greene giving ioformation on the unsanitary condition of the Cuban capital. 2400 w. Eng Rec—Jan. 7, 1899. No. 25100.

Municipal Engineers.

The Duties and Compensations of Municipal Engineers. A. D. Thompson. Enumerates the most important duties required, and gives statistics relating to salaries paid, with comments. 1300 w. Munic Engng—Jan., 1899. No. 25006 c.

Municipal Work.

A Review of Important Municipal Work in America. George H. Benzenburg. Read at Washington meeting of the Am. Soc. of Munic. Imp. Compiled from replies to a circular letter of inquiry. 4800 w. Munic Engng—Jan., 1899. No. 25007 c.

Sanitary Engineering.

Sanitary Engineering. The annual editorial survey deals principally with the question of the treatment of sewage. 1800 w. Engr, Lond—Jan., 1899. No. 25276 A.

See Civil Engineering, Miscellany.

Snow.

Experiments and Notes on the Removal of Snow. (Experimentelles and Kritisches über Schneebeseitigung.) Dr. Th. Weyl. A discussion of the various methods of disposal of snow in continental cities ; also of the impurities contained in snow. 2500 w. Gesundheits Ingenieur—Dec. 15, 1898. No. 25483 B.

Fighting Snow. Illustrates and describes plans used on roads in various cities of the west. 1000 w. St Ry Rev—Jan. 15, 1899. No. 25370 c.

Subways.

City Subways for Pipes and Wires. Henry F. Bryant. A discussion of present practice and its inconvenience and disadvantages, with an account of the Paris sewers, and suggestions for an improved system in American cities. Ill. 3400 w. Cosmopolitan—Feb., 1899. No. 25376.

West Indies.

Sanitary Conditions of Some West Indian Cities. F. C. S. Part first describes the conditions at Port au Prince, Hayti. 1800 w. San Plumb—Jan., 1, 1899. No. 25136.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

The Lehigh Valley Head Collision at West Dunellen, N. J. Brief illustrated account. 300 w. Eng News—Jan. 19, 1899. No. 25347.

Train Accidents in the United States in November. Detailed list and classified summary. 4800 w. R R Gaz—Jan. 13, 1899. No. 25215.

Central London Ry.

Some Notes of the Central London Railway. Gilbert Rosenbusch. Illustrates the tunnel work and gives interesting information. 1000 w. Eng News—Dec. 29, 1898. No. 24945,

European Travel.

How People Travel in Europe. Angus Sinclair. Briefly traces the progress of locomotion, describes the compartment car and comments on its drawbacks. Discussion follows. 11,000 w. N Y R R Club—Dec. 15, 1898. No. 25208.

Prussia.

The Prussian Railways in the Year 1848. (Die Prussischen Eisenbahnen im Jahre 1848.) A general description of the Prussian railway system fifty years ago, with map, and an account of the methods of operation and administration. 5000 w. Glaser's Annalen—Jan. 1, 1899. No. 25480 D.

Train Rules.

The New Standard Code. Editorial on the revised code of the Chesapeake & Ohio. 1800 w. R R Gaz—Jan. 20, 1899. No. 25336.

FINANCIAL.

New York Railroads.

The Railroad Situation in the State of New York. Editorial review of the sixteenth annual report of the board of railroad commissioners of the State of New York. 1400 w. Ry & Engng Rev—Jan. 7, 1899. No. 25180.

LEGAL.

Interstate Commerce.

Judge Knapp on the Present Status of the Law. Gives views of Hon. Martin A. Knapp as given in a lecture and informal talk at the Univ. of Pennsylvania. 1000 w. R R Gaz—Dec. 30, 1898. No. 24957.

The Interstate Commerce Commission. Abstract of report, taken from advance sheets, touching pooling, free storage, railroad earnings, safety appliances, and accidents. 2000 w. Ir Age—Jan. 19, 1899. No. 25323.

The Powers of the Interstate Commerce Commission. Milton H. Smith. A reply to the article of Charles A. Prouty, in the Nov. number of this publication. 5500 w. N Am Rev—Jan., 1899. No. 24978 D.

Kansas.

New Railroad Law in Kansas. Gives the principal provisions of the new bill. 1800 w. Ry Age—Jan. 13, 1899. No. 25263.

Receiverships.

The Movement in Receiverships during 1898. Editorial presenting facts showing that the railroads have practically recovered from the panic of 1893, and that it is probable that the railroad mileage in the hands of receivers will soon be as low as it ever has been in the history of the United States. 1500 w. R R Gaz—Jan. 6, 1899. No. 25077.

MOTIVE POWER AND EQUIPMENT.

Air Brake.

The Standard Air Brake as Applied to Tramways and Light Railway Cars. Illustrated detailed description, with statement of advantages claimed. 1500 w. Ry Wld—Jan. 5, 1899. No. 25505 A.

Body Bolsters.

Recent Freight Car Body Bolsters of the Chicago, Rock Island & Pacific. Illustrates designs in malleable iron and cast steel which provide ample strength for cars of 60,000 and 80,000 lbs. capacity, and have many features of interest. 1000 w. R R Gaz—Jan. 27, 1899. No. 25554.

Couplers.

The Saving of Lives and Limbs by Automatic Car Couplers. Editorial on recent statistics from the Interstate Commerce Commission's report, showing a marked reduction in the casualties among railway employees. 900 w. Eng News—Jan. 19, 1899. No. 25346.

Fast Runs.

Fast Runs on The Northern Railway of France. Charles Rous-Marten. Describes, with illustrations of the engines, a number of service runs of high-speed expresses of the Chemin de Fer du Nord, and gives numerous interesting and valuable data of locomotive performance. 6000 w. Engineering Magazine—Feb., 1899. No. 25439 B.

Freight Cars.

Steel Freight Cars of 100,000 lbs. Capacity, Pittsburg, Bessemer & Lake Erie R. R. Illustrates and describes one of the latest styles of steel cars. 1000 w. Eng News—Jan. 19, 1899. No. 25345.

Fuel Saving.

Fuel Saving on the Wabash. An account of the methods adopted which have resulted in great saving. 1500 w. R R Gaz—Jan. 20, 1899. No. 25335.

Locomotive Performance.

The Performance of the Vauclain Compound Locomotive. Extract from discussion by S. M. Vauclain, at the meeting of the St. Louis Ry. Club, showing that the results obtained by R. A. Smart, in the laboratory of Purdue Univ. were actually what takes place in service with this type of locomotive. 2300 w. R R Gaz—Dec. 30, 1898. No. 24956.

Locomotives.

A Heavy Consolidation for the Lehigh Valley. Dimensions and engravings showing the appearance of the engine, and the details of the boiler. 200 w. R R Gaz—Jan. 13, 1899. No. 25213.

A Locomotive with Oscillating Cylinders. Illustrates and describes a curious logging locomotive. 700 w. Sci Am—Dec. 31, 1898. No. 24940.

An Old Reading Engine. C. H. Caruthers. An account of an engine built in 1844 which exploded its boiler just 19 days after being put into service. The cause, as determined by investigations, is given. Ill. 1000 w. R R Gaz—Jan. 6, 1899. No. 25075.

French High Speed Compound Locomotives. From *La Nature*. Illustrates the locomotives of recent type, used on the Railway of the North, and gives the results realized in their operation. 1200 w. Sci Am Sup—Jan. 21, 1899. No 25343.

Locomotives for Japan. Descriptive specification, with engraving, of engines built in Schenectady. 400 w. R R Gaz—Jan. 27, 1899. No. 25557.

Passenger and Goods Locomotives for the Inter-Oceanic Railway, Mexico. Illustrated detailed descriptions of two powerful engines. 1000 w. Engng—Jan. 13, 1899. No. 25382 A.

Power and Speed of Locomotives. G. R. Henderson. Discussion of this subject, with diagrams. 600 w. R R Gaz—Jan. 27, 1899. No. 25559.

Rapid Mounting of a Locomotive. From *La Nature*. Describes the mounting of a high-speed freight engine in 66 hours in the shops of Epernay. Ill. 600 w. Sci Am Sup—Dec. 31, 1898. No. 24943.

The Relation Between Power and Speed of Locomotives. Editorial on recent views presented by Prof. Smart and Mr. Vauclain. 800 w. R R Gaz—Jan. 13, 1899. No. 25216.

Private Car.

Private Railway Car. Illustrated detailed description of the fine car built for H. M. Flagler. 500 w. Engr, Lond—Jan. 13, 1899. No. 25392 A.

Tests.

Tests of Materials and Their Purchase under Specifications. Alfred Lovell. Extracts from a paper read at meeting of the Northwest Ry. Club. Stating the advantages to buyer and seller, the economy, and desirability of buying under specification. 2500 w. Ry & Engng Rev—Dec. 31, 1898. No. 25005.

Train Control.

Prof. Elihu Thomson's System of Electric

Train Control. Illustrated description. 900 w. Elec Eng, N. Y.—Jan. 19, 1899. No. 25340.

Train Lighting.

The Electric Lighting of Trains. Robert A. Ross. Considers the several systems and their cost; their advantages and disadvantages, and the need of suiting the system to the conditions. 1800 w. Can Engr—Jan., 1899. No. 25328.

Train Resistance.

Train Resistance. A series of diagrams selected from a record from minute to minute of the work done by an engine in hauling a train on the Caledonian Ry. Also a chart of combined results. Editorial discussion of the diagrams and what they prove. 1800 w. Engr, Lond—Dec. 23, 1898. No. 25066 A.

NEW PROJECTS.

Arctic Railroad.

An Arctic Railroad. Information concerning a road to be built across northern Norway and Sweden, to furnish an outlet for the iron mines. 1300 w. Sci Am—Dec. 31, 1898. No. 24939.

Ecuador.

Railway in Ecuador. Report relative to the Guayaquil and Quito Railway. 2000 w. U. S. Cons Repts, No. 314—Jan. 3, 1899. No. 24965 D.

Indo-China.

The Railways of Indo China. (Les Chemins de Fer de L'Indo-China.) Henry Haguet. Description, with a map, of the proposed system of railways now under discussion in the French Chamber of Deputies. 1100 w. Jour des Transports—Dec. 3, 1898. No. 25424 B.

Japan.

A Progressive Japanese Railroad. Willard C. Tyler. Some interesting particulars in regard to the Sanyo Railway. 2000 w. Ry & Engng Rev—Jan. 21, 1899. No. 25372.

Trans-Caspian Railroad.

The Building of the Trans-Caspian Railroad. Notes from a paper by General Annenkoff, published in the Nov. Bul. of the International Railway Congress, concerning the methods pursued in the construction of the line. 1200 w. R R Gaz—Jan. 27, 1899. No. 25556.

PERMANENT WAY AND FIXTURES.

Block System.

Automatic Block Signals for Railways. (Verschluss der Fahrstrassen durch Stellwerke.) A paper read before the German Railway Society by Herr Leschinsky describing a variety of automatic electric block systems operated by the passing trains. 6000 w. Glaser's Annalen—Jan. 1, 1899. No. 25481 D.

Boston Terminal.

Opening of the Boston Terminal. An account of the opening of the new South Union Station, with description of the building, its equipment and general arrangement. 3300 w. R R Gaz—Jan. 6, 1899. No. 25073.

The New Boston Terminal Station. Elevation and illustrations with description of the new south station of the Boston Terminal Company. 2300 w. Ry Age—Jan. 6, 1899. No. 25142.

The New Southern Terminal Station, Boston. Illustrated description of the new depot of the Boston & Albany, and New York, New Haven & Hartford systems, which has accommodations for 2000 trains in 18 hours. Part I describes the station as a whole and the details of the foundations. 3000 w. Eng Rec—Dec. 31, 1898. Serial. 1st part. No. 24983.

China.

The Shanghai-Wusung Railway. (Die Shanghai-Wusung Bahn.) A brief account of this recently completed railway in China, with details of cost and views of the terminal stations. 1200 w. Zeitschr Oesterr Ing u Arch Ver—Dec. 30, 1898. No. 25477 B.

English Signaling.

Criticism of English Railroad Signaling. Charles Hansel. Cites cases of collisions and discusses the causes. 2200 w. R R Gaz—Dec. 30, 1898. No. 24958.

Gauge Widening.

On the Measurement of Super-Elevation and of the Widening of Gauge. A. Bewley. Considers devices used in this work and the simplest means of measuring for the adjustment of tracks. 1000 w. Ind Engng—Dec. 10, 1898. No. 25306 D.

Grain Warehouse.

A Grain Storage Warehouse Plant for Berlin. (Getreide-Silo-Anlage für Berlin.) M. Buhle. The prize essay of the German Society of Mechanical Engineers for 1896-1897, presenting a complete grain storage and handling scheme for the goods railway station at Berlin. Serial. Part I. 4000 w. 1 plate. Glaser's Annalen—Jan. 1, 1899. No. 25482 D.

Interlocking.

New Interlocking Plant at 101st Street, Chicago. Illustrated description. 1000 w. Ry & Engng Rev—Jan. 14, 1899. No. 25266.

Manning Rail.

The Manning Improved Rail. W. T. Manning. Description with diagrams, and the advantages claimed. Also editorial discussion. 3300 w. R R Gaz—Jan. 27, 1899. No. 25558.

Orleans Terminal.

Electric Traction on the Orléans Railway Extension. (La Traction Electrique sur le Prolongement de la Ligne d'Orléans dans Paris.) Short description of method of electric traction to be used in this tunnel line on account of difficulties of ventilation. 1800 w. Le Génie Civil—Dec. 17, 1898. No. 25411 D.

Extension of the Orléans Railway Line in Paris. (Prolongement de la Ligne d'Orléans de la Place Valhubert au Quai d'Orsay.) A. Boudon. An illustrated description of the present condition of the work. Serial. 1st part. 1500 w. Le Génie Civil—Jan. 7, 1899. No. 25416 D.

Permanent Track.

A Design for a Permanent Track for Steam Railways. J. W. Schaub. Illustrates and describes a design for a permanent roadbed and track. Also a lengthy editorial examining the above design and describing a construction developed by a member of the editorial staff. 7000 w. Eng News—Jan. 5, 1899. No. 25028.

Rail Joints.

The Weakest Point in Rail Joints. John King. Explains the writer's ideas of rail joints and fastenings. He considers the strength of the two inner bolts in the splice bar and the nearness of these bolts to the rail ends are the most important points. 700 w. R R Gaz—Jan. 20, 1899. No. 25334.

Rails.

On the Advantage of Using Heavier Rails for Railways Laid with Flange Rails. C. P. Sandberg. On the changed conditions which make it advisable to use more steel, thus securing cheaper roads, cheaper freights, and safety for higher speeds on British railways. 2000 w. Engng—Jan. 13, 1899. No. 25385 A.

Round-House.

New Round-House, 27th Street, Chicago, Illinois Central Ry. Plan of yards, boiler room and shops, with description. 900 w. Ry & Engng Rev—Dec. 31, 1898. No. 25004.

Signals.

Electric Signal Apparatus at Atlantic City, N. J. Illustrated description of the principal features of the electric signaling system recently installed by the weather bureau. 1000 w. W Elect'n—Jan. 14, 1899. No. 25253.

Sound Signalling at Sea. Investigations recently made by Emile Lacoine. A statement of problems and varying conditions and his means of obtaining distances. 3800 w. Engng—Jan. 6, 1899. Serial. 1st part. No. 25280 A.

Rail Circuit Signals on the Boston and Albany. George W. Blodgett. A discussion of the operation of signals under the control of a rail circuit, the construction work, batteries, &c., with report of the changes to the rail circuit on the B. & A. Ry. 2400 w. R R Gaz—Jan. 6, 1899. No. 25072.

Stations.

Pittsburg & Lake Erie R. R. Passenger Station at Beaver, Pa. Karl J. C. Zinck. Illustration, floor plan, and general plan of grounds, with description of an attractive station. 400 w. Eng News—Jan. 12, 1899. No. 25189.

The Design of Railway Stations. This first article of a series deals largely with the arrangements of stations, with some comment on architectural design. 3500 w. Eng News—Jan. 12, 1899. Serial. 1st part. No. 25187.

Tunnel Repairing.

Repairing a Tunnel on the Western and Atlantic R. R. W. H. Whorley. Read before the Engng. Assn. of the South. Describes this work on a tunnel passing through a ridge in the Chattanooga Mts. It was carried on without interrupting traffic. 1600 w. Eng News—Jan. 26, 1899. No. 25548.

TRAFFIC.

Car Carding.

The Canadian Pacific Car Carding System. A description of a system that has proved efficient. 1600 w. Ry Age—Jan. 20, 1899. No. 25374.

Railway Engineering.

Railway Engineering, and Its Relation to Traffic and Economic Conditions. E. E. Russell Tratman. A discussion of this branch, showing the important relations which it bears to railway operation and the railway system in general. 5400 w. Wisconsin Engr—Jan., 1899. No. 25203 D.

Rates.

Decline in Railway Rates and Profits. John Moody. Claims that while the actual return on capital has materially decreased, the actual return on money has not fallen off in the same ratio. Discusses the wealth-cheapening tendency and its cause. 1800 w. Gunton's Mag—Jan., 1899. No. 25071 C.

Stable Rates. Editorial discussion of freight rates and the agreements of the presidents of the trunk lines. 1600 w. R R Gaz—Jan. 27, 1899. No. 25560.

The B. & O. Receivers on Rate Cutting. Copy of a letter sent to the Interstate Commerce Commission last week, with editorial comment. 1300 w. Ry & Engng Rev—Dec. 31, 1898. No. 25003.

The Outlook for Railroad Rates. Brief discussion of points affected by the agreement made between the presidents of the principal lines and the Interstate Commerce Commission. 700 w. Bradstreet's—Jan. 28, 1899. No. 25590.

Tonnage.

Train Tonnage for Locomotives. Relating to the system recently put into effect on the Ontario & Quebec Div. of the Canadian Pacific Railway. 600 w. Ry Age—Jan. 13, 1899. No. 25262.

Traffic.

Events of the Year in the Traffic Field. Editorial review of the events and experiences during 1898. 2000 w. R R Gaz—Dec. 30, 1898. No. 24959.

STREET AND ELECTRIC TRAMWAYS.

Accounts.

An Ideal System of Street Railway Accounts. A. O. Kittredge. Gives a chart of analysis and classification, with description of a system proved successful in many enterprises. 3000 w. St Ry Jour—Jan., 1899. No. 25035 D.

Trip and Mileage Accounts on the Lynn & Boston. F. E. Smith. Explains the details of the system used in keeping an account of the trips run from which the mileage is computed. 1300 w. St Ry Rev—Jan. 15, 1899. No. 25369 C.

Conduit and Trolley.

Trolley and Conduit Tramway in Paris. (Tramway Electrique à Trolley et à Caniveau de la Place de la Bastille à Charenton.) G. Boeto. A well illustrated and complete description of this new line. The conduit construction is similar to that recently installed in New York.

5000 w. 1 large plate. Le Génie Civil—Dec. 31, 1898. No. 25415 D.

Contact System.

Campbell Surface Contact System of Electric Traction. Illustrates and describes this system and states its advantages. 1100 w. Elec Eng, N. Y.—Jan. 5, 1899. No. 25174.

Cork, Ireland.

Cork Electric Tramways and Electric Works. Full description of the electrical works of the Cork Electric Tramway and Lighting Co., Ltd., with illustrations and map. 3500 w. Elec Eng, Lond—Dec. 23, 1898. No. 25047 A.

Electric Tramway System of Cork, Ireland. Gives map of tramways with brief description. 2200 w. St Ry Jour—Jan., 1899. No. 25036 D.

Dublin.

See Electrical Engineering, Generating Stations.

Electrical Survey.

An Electrical Survey of the Borough of Manhattan, New York City. Discussion of A. A. Kundson's paper on this topic. 2400 w. Trans of Am Inst of Elec Engs—Nov., 1898. No. 25521 D.

Electric Traction.

Electricity for Operating Trains on Italian Railways. (L'Energia Elettrica Applicata ai Treni delle Ferrovie Italiane.) A study of the possibilities of utilizing the numerous Italian water-powers for the operation of the present steam railway system, containing some interesting data. 2400 w. Annali d Soc d Ing e d Archit Ital—Sept., Oct., 1898. No. 24871 E.

Generating Stations.

See Electrical Engineering.

Germany.

Statistics of the Electric Tramways of Germany. (Die Statistik der Elektrischen Bahnen in Deutschland.) The annual review of electric tramways with a fully tabulated statement of the development during 1897-1898. 12,000 w. Elektrotech Zeitschr—Jan. 5, 1899. No. 25445 B.

Light Cars.

Light Passenger Cars—The Manhattan Elevated Railroad. Illustrates the framing of the cars which have been in use on the Manhattan Elevated Railroad in New York, and given satfactory service. 800 w. R R Car Jour--Jan., 1899. No. 25231.

Lyons, France.

Electric Traction at Lyons, France. Brief account of the recent change of all lines to electric traction, describing the system adopted. 1500 w. Elec Wld—Dec. 31, 1898. No. 24923.

Electric Traction at Lyons. (La Traction Electrique à Lyon.) Description, with maps and illustrations of the 12 lines of the Compagnie des Omnibus et Tramways at Lyons. Both trolley and conduit systems are in use. 3000 w. L'Electricien—Nov. 19, 1898. No. 24867 B.

Porto Rico.

The Exploitation of Electric Tramways in Porto Rico. Antonio Mattei Lluveras. This well illustrated article describes the needs of Porto Rico for some system of transportation better than mule back. It contains much valuable information concerning the resources of the island. 4200 w. Engineering Magazine—Feb., 1899. No. 25440 B.

Rapid Transit.

A Feasible Plan for the New York Rapid Transit Ry. Editorial, discussing some of the engineering features of the enterprise, and outlining a plan based on securing an arrangrment with the Metropolitan St. Ry. Co. for the operation of a system of express tunnels beneath some of the North and South lines. 2200 w. Eng News—Dec. 29, 1898. No. 24947.

Storage Station.

See Electrical Engineering, Generating Stations.

Street Railway Changes.

Equipment of the Broadway Cable Line with Electricity. Illustrates and describes the work being carried on by the Metropolitan Street Railway Co. 1000 w. Sci Am—Dec. 24, 1898. No. 24701.

Three-Phase Railway.

The Three-Phase Electric Railway from Stausstadt to Engelberg. Charles Rochat. Illustrates and describes this road, its electric equipment, rolling stock, and operation. 3800 w. St Ry Jour—Jan., 1899. No. 25033 D.

Track.

Some Examples of Tracklaying for Street Railways. (Einige Aufgaben über Berechnung von Gleisanlagen für Strassenbahnen.) Especially devoted to methods of laying out curves and turnouts, given problems being solved in detail. 2500 w. Ill. Zeitschr f Klein u Strassenbahnwesen—Dec. 1, 1898. No. 24829 D.

Tramways.

A Combined Overhead and Conduit System in Paris. Illustrated detailed description. Great care was given to the overhead work, with most pleasing results. The line has many innovations in its constructional features. 2200 w. Ry Wld—Jan. 5, 1899. No. 25504 A.

Barcelona Electric Tramways. An illustrated detailed description of the tramways of the largest city in Spain. 4000 w. Ry Wld—Jan. 5, 1899. No. 25503 A.

Tramway Schemes for 1899. A report of English, Scotch and Irish schemes for the coming year. 2200 w. Transport—Dec. 30, 1898. No. 25134 A.

Underground Railroads.

For Paris Underground Railroads. From the *Moniteur Industriel*. An account of the plan to construct 33½ miles of underground electric roads. 500 w. R R Gaz—Nov. 25, 1898. No. 24207.

Paris Metropolitan Underground Electric Road. Some particulars relating to this road now in process of construction. Ill. 600 w. Elec Eng, N. Y.—Jan. 26, 1899. No. 25533.

BOOK REVIEWS.

COMMERCIAL CUBA. A BOOK FOR BUSINESS MEN, by William J. Clark, with an introduction by E. Sherman Gould. Illustrated. New York: Charles Scribner's Sons. 1898

This work may fairly be called the most important collection of data regarding Cuba that has been published. Perhaps its most noticeable feature is the directness with which the author has gone to work to justify his title,—to write a business book for business men. In the majority of cases books of this character, those purporting to give facts of value, err either by misstatements of the conditions with which they deal, or by the inclusion of matter without interest to the exclusion of matter of really vital importance. The handsome volume that Mr. Clark has compiled, largely from the results of his personal travel and observation in the island, is without doubt trustworthy, and equally full of matters that are of real interest to one wishing either to go to Cuba, or to enter into any business relation with Cuban people. It is essentially a book for business men.

It should not be thought that this fact robs the work of any interest to others than those contemplating entering business relations with the island. On the contrary the author has succeeded in maintaining an admirable style throughout, and in presenting his facts in a very attractive guise. The fine illustrations accompanying the text are well chosen to show the peculiarities of Cuban scenery and manners, while the numerous maps and plans of cities will be found of great value.

The necessary work of demolition having been accomplished in the island, and the conditions which have so long restrained its progress having been removed, the vastly more important work of reconstruction is about to begin. To the English-speaking people who will have this work in hand such books as this volume of Mr. Clark's will be of the highest value. He has recognised the importance of understanding the social and personal peculiarities of the Cubans, and his chapters on these points are not only interesting but valuable. The chapter on the climate of the island and the rules to be observed for the preservation of health by unacclimated foreigners is one that will be of great use to a stranger visiting the island. Without being in any sense either a guidebook or a mere compilation of statistics, the work succeeds in being both a collection of data and a manual for travelers; but perhaps the best praise that can be given it is that it lives up to its title,—a book for business men. It is emphatically that, and, as such, a work of real importance and permanent value.

MANUFACTURERS' EXPORT CODE, by Charles L. Seeger. New York: United States Industrial Publishing Co. 1898.

This telegraphic code presents several novel and distinctive features which recommend it to English-speaking manufacturers seeking trade in Spanish-speaking countries. The book can be used with equal facility by both English- and Spanish-speaking persons, the code words appearing in the centre of the page with the translation on either side in these two languages. A strictly alphabetical arrangement of phrases by principal words is, therefore, impossible; but, on the other hand, the arrangement and classification of the different subjects render them quite accessible for quick and effective use, while a very complete alphabetical index in both English and Spanish serves to direct the new user of the code to desired subjects. The code is designed primarily for the use of those making or dealing in American manufactures and products and raw materials, and for this reason many phrases found in general alphabetical codes are omitted, while in compensation therefor it has been possible to go into fuller details regarding the goods themselves, and the many different ways of ordering, shipping, specifying particular kinds of goods, payments, etc. The arrangement of the code is very ingenious, and one's appreciation of it grows with familiarity. The verb has been taken as the keyword for any general phrase, and, by a tabular arrangement, twenty-four different combinations of each of some 300 verbs, or about 7,000 different phrases in each language, are given in the space of only twenty-three pages. Manufactures and products are treated in a similar manner, with the result that a single word message can be made to ask discounts on almost anything, or order it, while two or more words can be made to ask any one of several questions, give shipping directions, specify mode of payment, or manufacturer and brand if the order is given through a commission merchant. About 100,000 messages in both Spanish and English are contained in the code, covering all ordinary business transactions. The ciphers used are taken from the vocabulary compiled by the International Telegraph Bureau, at Berne, and are consequently transmissible by all cables of the world.

LIGHTING BY ACETYLENE, Generators, Burners, and Electric Furnaces. By William E. Gibbs, M.E. Second Edition. New York: D. Van Nostrand Co. London: Crosby, Lockwood and Son. 1899.

The first edition of Mr. Gibbs's book appeared early in 1898 and was a welcome contribution to the literature of a subject about which but little authoritative information had been given.

That it was needed is shown by the fact that a second edition has been demanded, and in this revision the progress which has been made during the interval has been thoroughly covered, and the work brought up to date.

The book is an excelled companion to the well-known French treatise of Pellissier, but, as the latter has not as yet been translated, the new work is welcome as giving to English readers a record of the most important advances which have been made in lighting by acetylene. Mr. Gibbs rightly considers the best form of generator that in which the carbide is entirely submerged in a comparatively large bulk of water, and a number of generators on this and other plans are described and illustrated. The author's experiments upon several forms of generators are given somewhat in detail, and a list of United States Patents on Calcium Carbide and Acetylene Apparatus from January, 1893, to February, 1898, forms a valuable appendix.

METHODS OF IRON ANALYSIS, Contributed by the Chemists in Charge, and edited by a Committee of the Chemical Section, Engineers' Society of Western Pennsylvania. Easton, Pa.: Chemical Publishing Co. 1898.

The general establishment of chemical laboratories by the manufacturers of iron and steel has led to the accumulation of much practical experience in special lines of analysis, and much of this experience has until recently been retained in the establishments in which it was acquired. During 1896 the Engineers' Society of Western Pennsylvania arranged, by correspondence, to gather the various methods in actual use in the laboratories of the most important furnaces and works about Pittsburg, and the result is this valuable and convenient volume.

The collection includes brief working descriptions of the methods in use for actual work, arranged in such a manner as to represent as correctly as possible the present status of analytical chemistry as applied to iron and steel; methods being given for the following substances:

In Ores,—Silica, iron, phosphorus, manganese;

In Pig-Iron,—Silicon, sulphur, phosphorus, manganese;

In Steel,—Carbon (by combustion), sulphur, phosphorus, manganese nickel.

The laboratories which have thus liberally placed the results of their experience at the service of the public include those of such important works as the Carnegie Steel Co., the Black Diamond Steel Works, the Hainsworth Steel Co., McIntosh, Hemphill & Co., Pennsylvania Railroad Company, W. Dewees Wood Co., and many others, and methods which have received the approval of such establishments will be received with much interest by other workers in the same branch of chemistry.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

C. W. Hunt Company, New York.=Handsome catalogue of steam and electric hoisting engines, especially as used in connection with the coal handling machinery of the same firm. Photographs of numerous installations are shown.

The Watson-Stillman Co., New York.=Illustrated index of hydraulic tools and miscellaneous machinery, containing small illustrations of all the numerous machines made by this firm, with names and reference numbers indicating the sheets in which fuller information is given.

Acme Machinery Company, Cleveland, Ohio, U. S. A.=Catalogue of bolt and nut machinery, including dies, die-heads, bolt cutters, nut tappers, heading and forging machines, and appliances. The machines are well illustrated and full specifications of each are given.

James G. Biddle, Philadelphia, Pa., U. S. A. =Catalogue B., of electrical measuring instruments, illustrating the products of the various makers whose instruments are handled. A great variety of high grade electrical instruments is shown, and many of them are described at length.

Fraser & Chalmers, Chicago, Ill., U. S. A.=Catalogues (*a*) of the "Comet" rock crusher; (*b*) the ball pulverizing mill; and (*c*) of the Sederholm steam boiler, giving in each case detailed and illustrated descriptions of the mechanism and operation, together with testimonials of users.

Sprague Electric Company, New York.=Beautifully illustrated and printed catalogue of the Lundell electric motors, showing the construction of the various types of motors and applications to different machines. Efficiency curves for various loads are given, showing the excellent performance of these motors under widely varying loads.

The Direct Separator Company, Syracuse, N.Y., U. S. A.=A very handsome catalogue of the steam separators, oil separators, ammonia separators, marine boiler separators, and exhaust heads invented by Professor John E. Sweet, giving reports of tests and general information concerning the removal of entrained moisture from steam.

Patterson, Gottfried & Hunter, Limited, New York.=Catalogue of machine tools, machinist's hardware, and supplies for general machine shop use, representing the products of various important establishments.

General Electric Company, Schenectady, N.Y., U. S. A.=Handsome catalogue of enclosed arc lamps, illustrating lamps of this construction for both direct and alternating currents of various voltages. Various methods of suspension and of distribution of light are shown, and general information given.

B. F. Sturtevant Co., Boston, Mass., U. S. A. =A large list of users of the Sturtevant system of mechanical draft, including only the names of those using large plants with engine-driven fans. The list includes many vessels in the merchant marine as well as navy, and also a number of pleasure yachts.

The Waterbury Farrel Foundry and Machine Company, Waterbury, Conn., U. S. A.=Pamphlet catalogue, showing in miniature a large line of sheet-metal working machines described more fully in larger catalogues. The machines are in each case briefly described, and page references given to catalogues in which fuller information may be found.

The Garrett Engine, Boiler, and Machine Works, Garrett, Ind., U. S. A.=Catalogue of the "Model" gas and gasoline engine, illustrating this very simple internal combustion engine, with table of dimensions and prices.

Joseph Dixon Crucible Co., Jersey City, N. J., U. S. A.=Pamphlet catalogue of the various grades of lead pencils made by the Dixon Crucible Company, attractively illustrated with reproductions of pencil sketches and drawings, and containing an essay upon the use of the lead pencil in artistic work.

The Philippines Company, New York.=A handbook of information concerning Manila and the Philippine Islands, for use in connection with the express and transportation business conducted by the company. An excellent sheet map of the city of Manila and of the group of islands is given.

R. & J. Dempster, Ltd., Newton Heath, Manchester, England.=Handsome cloth-bound catalogue of gas works plant; containing over 300 pages of illustrations and descriptions of all kinds of gas works equipment. In many cases, prices are given, and as the information is very full, the catalogue is almost a treatise on gas works practice, of value to all gas engineers.

James T. Donald & Co., Ltd., Glasgow, Scotland.=Catalogue of tools for engineers, ship-builders, contractors, etc. The catalogue comprises generally all the tools in general use as well as pumps, boilers, engines, etc. Good index and well illustrated.

W. F. Dennis & Co., 11, Billiter St., London, E. C.=General price list of wire, wire ropes, wire fencing, etc., in iron and steel, and also of music wire, bronze, copper and brass wires. The catalogue is furnished with a finger index to the pages. The goods are all made by Felten & Guilleaume of Cologne.

Schischkar & Co., 67, Stafford St., Birmingham, England.=Catalogue of machine tools of all usual shop types, and also of special bicycle making machinery. One section is devoted to engineers hand and sundry tools. The catalogue is a model of the printers art.

Southgate Engineering Company Ltd., New Southgate, England.=Catalogue of machinery for the manufacture of projectiles with specifications and illustrations.

Clarke Chapman & Co., Ltd., Victoria Works, Gateshead-on-Tyne, England.=(*a*) Price list and catalogue of steam winches, wharf cranes, steering gear and various discharging machinery, including Temperley Transporter. Fully illustrated. (*b*) Circular describing an unbreakable barrel for steam trawler winches. (*c*) Circular describing the "Petersen" water-tube boiler. (*d*) Circular describing Scott's patent steering gear.

Robert Warner & Co., Walton-on-Naze, Essex, England.=Well printed and illustrated catalogue of pumps and pumping machinery; also of wind mills, artesian well boring tools and water works equipment.

Beaumonts Pump Works, Booth St., Edgeley, Stockport, England.=Circular describing Beaumonts Cop Dyeing Machine.

Patent Woolen Cloth Co., Elmwood Mills, Leeds, England.=Price list of felt polishing bobs.

James B. Petter & Sons, Yeovil, England.= Price list of the Petter patent petroleum engine, with illustrations of its application to pumping, etc.

Newton Electrical Works, Taunton, England. =Sheets illustrating electro plating dynamos and electric haulage plants.

Conrad Knap & Co., Ltd., 11, Queen Victoria St. London, E. C. = Circular describing the "Root" watertube boiler.

O. Berend & Co., Ltd., Dunedin House, Basinghall Avenue, London.=Price lists of (*a*) Hartmann and Braun's switchboard instruments, (*b*) micrometers, cylinder gauges, etc.

J. W. Titt, Warminster, England.=Circular describing a wind engine installation in Italy.

Carson & Toone, Warminster, England.=Price list of the "Advance" Oil Engine, with illustrations and description.

David Bridge & Co., King Street Works, Salford, Manchester, England.=(*a*) List of users of Heywood & Bridges friction clutches with illustrations of the different types. (*b*) Larger pamphlet giving fuller details of the clutch, and testimonials from users.

Taylor & Challen, Ltd., Constitution Hill, Birmingham, England.=Illustrated catalogue of presses for all kinds of service and driven by hand, belt or hydraulic power; also of shears, lathes, steam engines, etc.

E. & J. Richardson, Elswick Leather Works, Newcastle-on-Tyne, England. = Price list of leather belting, hose pipes and pump leathers.

The Cape Asbestos Co., Ltd, 8, Minories, London, E. C.=(*a*) Circular describing the blue asbestos removable pipe covering. (*b*) Pamphlet giving list of steamships using the above covering, with results of tests made by the Italian naval authorities and testimonials. (*c*) Folder with prices and statement of advantages.

J. Proctor, Hammerson Street Iron Works, Burnley, England. = (*a*) Circulars describing "Proctors" mechanical stoker and a new system of coking stoker, with usual data as to users, testimonials, etc. (*b*) Circular giving results of the International Competition in France (1894–97) in which Proctors stokers were successful.

National Boiler & General Insurance Co., Ltd., St. Ann's Square, Manchester, England.=Price list of the double cone fusible plugs recommended by this insurance company.

Edwin Verity, 168, Briggate, Leeds, England. =Catalogue of specialties for the building trades, principally metal fittings and accessories for doors and windows.

The Uskside Engineering & Rivet Co., Ltd., Newport, Mon., England.=(*a*) Illustrated catalogue of colliery and briquette making machinery. (*b*) Leaflets illustrating recent designs of electric pumps, hauling engines, coke pushers, etc.

The Unbreakable Pulley and Mill Gearing Co., Ltd., West Gorton, Manchester, England.=Cloth bound catalogue entitled "A Treatise on the Economical Transmission of Power," giving useful data on the pulley, shafting, etc. Also illustrations, full particulars and prices of the various types of couplings, hangers, pedestals, pulleys, shafting, etc., which are the speciality of the firm.

Arthur M. Wild, Sheffield, England.=Illustrated catalogue of engineer's machine tools, including lathes, milling, planing, dulling and shaping machines. The sizes, specifications, and approximate shipping weights are given.

The Electrical Power Storage Co., Ltd., 4, Great Winchester St., London.=Illustrated price list of storage batteries, with full information as to maintenance, method of charging, etc., also full data as to complete sets of storage cells, and sundries for this branch of engineering.

Fielding & Platt, Ltd., Gloucester, England.= Catalogue of the "Fielding" Gas Engine, with illustrations of types up to 100 H. P.; also of the "Fielding" Oil Engine and of gas plants for heating and power purposes.

The Rankine Patent Feed Water Filter Co., 11, Oriel Chambers, Water St., Liverpool, England. =Circular describing the Rankine patent feed water filters.

Browett Lindley & Co., Ltd., Patricroft, Manchester, England.=Circular illustrating and describing the Begtrup Inertia Shaft Covernor.

R. A. Lister & Co., Ltd., Dursley, Glos., England.=Folder describing adjustable tine and link harrows.

Leslie E. Clift & Co., 1, Holborn Place, High Holborn, London.=Catalogue entitled "Wood Engraving for Engineers," showing specimens of work.

Green & Boulding, 105, Bunhill Row, London, E. C.=Catalogue of engineering specialties, including injectors, metallic packings, and valves.

New Conveyor Co., Ltd., Smethwick, Birmingham, England.=Pamphlet containing illustrated description of the Conveyor works and of plants erected by the company.

The Chloride Electrical Storage Syndicate, Ltd., Clifton Junction, Manchester, England.= Illustrated catalogues of (*a*) storage batteries for launches and yachts (*b*) of lighting batteries. Both catalogues are a model of the printers art.

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